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A Review
of
The Cooperative State-Federal Brucellosis
Eradication Program

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**Highlights
of
The Review
of
The Cooperative State-Federal Brucellosis
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A REVIEW OF THE COOPERATIVE STATE-FEDERAL BRUCELLOSIS ERADICATION

PROGRAM

In response to the Congressional request for a restudy of the role of vaccination in the Cooperative State-Federal brucellosis eradication program, the Department has conducted a comprehensive and critical review of all phases of this program with special reference to vaccination.

A PROGRAM INITIATED

As a result of public interest and research conducted by the Department and State institutions, a national brucellosis eradication program was initiated in cooperation with the States on July 1, 1934. This program became known as the "test and slaughter" program. Supported by sanitary procedures, the program consisted of the blood testing of herds for the presence of brucellosis and the removal of infected animals. During the next seven years, progress was made in reducing infection in individual herds. However, because the program was not conducted on a uniform area basis and no immunizing agent was available, gains made in the program became increasingly difficult to maintain. With vaccination incorporated into the program in 1941, and with the application of other procedures in later years, the term "test and slaughter" is no longer applicable.

VACCINATION

In 1941, Brucella abortus, Strain 19 vaccine, developed by Department scientists, was introduced as a part of the cooperative State-Federal brucellosis eradication program. This proved to be a valuable adjunct to the program in providing a useful degree of resistance to brucellosis in otherwise susceptible animals. Vaccination has been found to be effective in lowering animal infection rates but has had little effect on reducing herd infection levels. Research and field studies indicate that brucellosis cannot be eradicated by vaccination alone. However, this procedure serves a useful purpose in reducing high infection levels to a point where eradication is practical and can be accomplished through the application of other eradication tools. When available procedures are applied in an appropriate manner, no difficulty is being experienced in eradicating brucellosis.

Other Program Procedures

In 1947, realizing that brucellosis should be treated as a national problem, the Uniform Methods and Rules for the eradication of brucellosis were formulated by the United States Livestock Sanitary Association, an organization of livestock producers, State-Federal livestock sanitary officials and others. These recommendations, approved by the Department, provide guidelines for eradicating the disease on a herd, area, State, and National basis.

In 1952, the Brucellosis Milk Ring Test (BRT) was incorporated into the brucellosis program. It provides an effective means of detecting dairy herds having brucellosis and essentially eliminates all of the "down-the-road" testing otherwise required.

In 1959, Market Cattle Testing (MCT) was initiated as a part of the program. This is a screening procedure for beef herds comparable to the BRT for dairy herds.

Program Acceptance

Although the principle of brucellosis eradication is not yet fully accepted, the vast majority of livestock owners do not want to live with this disease. Today, 82 percent of the counties in the United States enjoy the benefits of Modified Certified Brucellosis Area or Certified Brucellosis-Free Area status. The brucellosis eradication program has been widely supported by the beef cattle industry as evidenced by the fact that 70.8 percent of the counties in the 17 western States are certified.

If the majority of livestock owners in the U.S.A. had not believed in and supported the eradication program, the progress accomplished to date would not have been possible. In all, 88 percent of the counties in the United States are free or are working toward eradication of brucellosis on a coordinated complete area basis. This leaves only 12 percent of the counties yet to initiate an area eradication program. However, these counties already are conducting activities leading to complete area programs.

Protecting Gains Made

With 82 percent of the Nation's counties now certified, it becomes increasingly important that maximum protection be given these areas against re-exposure. Recent surveys reveal a striking difference between the brucellosis status of cattle originating in certified areas as opposed to noncertified areas.

During the period of July 1957 to September 1960 a survey was conducted to determine the brucellosis status of cattle moving interstate from various sections of the country. In this study, a total of 107,286 cattle were tested at destination within 60 days of import. In the case of animals moving interstate from certified areas, only 31 of 76,725 tested -- 1 in 2,475 -- were found to be reactors. In contrast, 201 of 30,561 animals tested from noncertified areas, or 1 in 152, were claimed as reactors when tested. This evidence indicates the need for vigilance on the part of State and Federal authorities in order to minimize the risks connected with movements of animals from non-certified areas.

Goals Established

The need for realistic timetables and goals for nationwide certification and eradication was recognized by the United States Livestock Sanitary Association, the National Brucellosis Committee, and the Department. Such goals were established in 1960. These call for nationwide Modified Certified Brucellosis Area status by 1965 and complete eradication of brucellosis by 1975. There is every indication that these goals can be met through the proper application of tools and present knowledge.

When eradication has been achieved and dangers of exposure eliminated, there will be no further need for Strain 19 vaccination.

Sweden and Norway Eradicate Brucellosis

Sweden freed its livestock of brucellosis with an eradication program which began in 1944, and was completed in 1957. The total cost of eradication was far less than the losses suffered during a single year in the 1930's. Their program was comparable to that of the United States, except that Brucella abortus Strain 19 vaccine was used only in acutely infected herds. All calf vaccinations ceased in 1951, thus eliminating a continuing expense to the livestock industry. Norway reported eradication of brucellosis in 1949. This was accomplished without the use of vaccine.

The Consultants Review

Recognized authorities in the field of brucellosis eradication and other interested livestock representatives were asked to assist the Department in making a review of the Cooperative State-Federal Brucellosis Eradication Program. During this two-day conference, all aspects of the program were thoroughly examined and reviewed. The Department appreciates the assistance rendered by the following consultants who participated in the review:

Dr. Robert K. Anderson
 College of Veterinary Medicine
 University of Minnesota
 St. Paul, Minnesota

Mr. W. D. Knox, Member
 National Brucellosis Committee
 Editor, Hoard's Dairyman
 Fort Atkinson, Wisconsin

Mr. Bob Laramore
 Cattle Rancher
 Chairman, Brucellosis Study Committee
 American National Cattlemen's Assoc.
 Gillette, Wyoming

Honorable Donald N. McDowell
 Executive Committee
 National Association of Commissioners
 and Directors of Agriculture
 Director, Department of Agriculture
 Madison, Wisconsin

Mr. C. G. Scruggs, Vice Chairman
 National Brucellosis Committee
 Editor, The Progressive Farmer
 546 Rio Grande Building
 Dallas, Texas

Dr. R. W. Smith, Chairman
 Brucellosis Committee
 U. S. Livestock Sanitary Assoc.
 State Veterinarian
 Department of Agriculture
 State House Annex
 Concord, New Hampshire

Dr. James H. Steele
 Chief Veterinary Officer
 Communicable Disease Center
 Public Health Service
 Atlanta, Georgia

Mr. Edward Wadsworth
 Cattle Rancher
 Member, Livestock Sanitation
 Committee, American National
 Cattlemen's Association
 Old Selma Road
 Prattville, Alabama

Mr. Archie Wilson
 Cattle Rancher
 Chairman, Montana Livestock
 Sanitary Board
 St. Xavier, Montana

Dr. H. G. Wixom, Chief
 Division of Animal Industry
 Department of Agriculture
 1220 N Street, Agriculture Bldg.
 Sacramento, California

As a result of this conference, these conclusions were reached by the participants:

1. Considering the progress made, under no circumstances should the final goal of the program be anything short of eradication.
2. Although Strain 19 vaccine provides an important aid in the brucellosis program, vaccination alone will not achieve eradication.
3. A complete eradication program utilizes all available procedures including vaccination, blood testing, milk ring testing, and market cattle testing.
4. It was the consensus that intrastate and interstate regulations should be reviewed and modified as necessary to protect the progress already made.

5. In addition to the economic benefits to be derived from the eradication of brucellosis from livestock, there are also significant public health advantages. When brucellosis has been eradicated from all susceptible livestock in this country, there will no longer be any source of human brucellosis or undulant fever.
6. The Department and State officials should review program procedures in the various States in order to assure most efficient use of funds in the eradication of brucellosis.
7. Although it is believed that available tools and knowledge are adequate to eradicate brucellosis in this country, it is recommended that research be continued as may be needed to support the program in the future.
8. Considering the economy and the effectiveness of market cattle testing, it was recommended that Federal support of State programs be related to the extent that market cattle testing is being used.
9. The intensified effort to eradicate the disease from swine should be continued with special emphasis on the development of a market swine testing program.
10. Educational activities should be accelerated in the lagging States to encourage increased support of eradication efforts.

Since the program is conducted in cooperation with the various States, the Department plans to bring these recommendations to the attention of the appropriate officials in the various States as a means of considering them for inclusion in the program.

Appendix I

A Review
of
The Cooperative State-Federal Brucellosis
Eradication Program

Agricultural Research Service

United States Department of Agriculture

January 1964

BACKGROUND INFORMATION ON COOPERATIVE STATE-FEDERAL BRUCELLOSIS
ERADICATION PROGRAM

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BACKGROUND INFORMATION ON COOPERATIVE STATE-FEDERAL BRUCELLOSIS ERADICATION PROGRAM

HISTORY

Brucellosis is a specific infectious disease of animals and man caused by bacteria of the genus Brucella. The disease apparently was prevalent in cattle, goats, and swine centuries ago, as the disease in man (undulant fever) was described in early histories. Colonel David Bruce, British Army surgeon, studied the cause of "Malta Fever", a disease of man on the Island of Malta. Humans contracted the disease after drinking raw milk from infected goats. In 1887, an organism was isolated which was called Micrococcus melitensis. This microorganism was later named Brucella in honor of Colonel Bruce. In 1897, in Denmark, Bang and Stribolt isolated a microorganism, now known as Brucella abortus, from an aborting cow. Seventeen years later Dr. Jacob Traum isolated Brucella suis from swine affected with brucellosis in the United States. In 1918, Dr. Alice Evans (USBAI) established the close relationship between Brucella abortus (bovine) and Brucella melitensis. It has been determined that interspecies transmission of Brucella types can occur, but primarily, Brucella abortus is found in cattle; Brucella suis in swine; and Brucella melitensis in goats. Continued field studies indicate that cross infections are of little significance and do not constitute a problem in brucellosis eradication.

Brucellosis is the name now used to designate infections in animals and man caused by any member of the genus Brucella, but for continuity purposes this word will be used in reference to bovine brucellosis unless otherwise denoted.

Brucellosis in Humans and Animals

The infection of livestock results from contact with Brucella-contaminated discharges of affected animals. The organism reaches the reproductive organs, udder and other tissues by way of the blood stream. Clinical signs may be abortion, retained fetal membranes, sterility, lameness, abscesses of various tissues, persistent abnormal discharges, and mastitis. Secondary infections may also occur. Not all infected animals exhibit clinical signs, but most will discharge the organism, either intermittently or continuously. Dissemination is most pronounced at or near parturition time.

Humans contract brucellosis as a result of contact with infected animals and their products, but not from other humans. Therefore, livestock producers, veterinarians and packing plant workers are most commonly affected because of occupational hazards. The disease in man is a serious, debilitating, incapacitating illness of long duration with frequent relapses and an occasional death.

Basic Federal Authority

Basic Federal authority and Department responsibility for conducting a cooperative State-Federal brucellosis eradication program is provided through the Congressional Act of 1884 (23 Stat., 31). This Act authorized the formation

of an agency within the United States Department of Agriculture to provide (among other things) a means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases of domestic animals. Additions to the original Act which apply to the brucellosis eradication program are as follows:

1903 (32 Stat., 791) to prevent introduction or dissemination of any contagious infectious or communicable disease of animals from a foreign country into the United States or from one State...to another

1905 (33 Stat., 1264) to clarify and broaden the quarantine authority

1951 (65 Stat., 693) to permit interstate shipment of brucellosis and paratuberculosis reactors

The Secretary of Agriculture promulgated regulations in 1957 designed to protect substantial gains in eradication and provide for more rapid progress toward eradication. These are incorporated in the Code of Federal Regulations, Title 9, Chapter 1, Subchapter "C", Part 78. AUTHORITY: secs. 4, 5, 23 Stat. 32, as amended, secs. 1, 2, 32 Stat. 791, as amended, 792, as amended, sec. 3, 33 Stat. 1265, as amended, sec. 13, 65 Stat. 693: 21 U. S. C. 111-113, 114a-1, 120, 121, 125. Interpret or apply secs. 6, 7, 23 Stat. 32, as amended; 21 U. S. C. 115, 117.

Also Part 51, Title 9, Code of Federal Regulations (cattle destroyed because of brucellosis, tuberculosis, or paratuberculosis) provides for indemnification to owners in the case of animals destroyed under the cooperative State-Federal brucellosis eradication program. AUTHORITY: sec. 3, 23 Stat. 32, as amended, sec. 2, 32 Stat. 792, as amended, sec. 11, 58 Stat. 734, as amended: 21 U. S. C. 112, 113, 120, 125.

The above regulations superceded the former Bureau of Animal Industry Order 309 and amendments.

Development of the Cooperative State-Federal Brucellosis Eradication Program

Cooperation between the States and the Department is based upon memorandums of understanding executed by State Officials and the Department. These outline the responsibilities and obligations of both Governments in carrying out cooperative animal disease eradication programs within the respective States.

The livestock industry in the 1920's and 1930's requested, through their State and Federal representatives, assistance in combating brucellosis. During this period, sporadic testing and vaccination of livestock were carried out by independent groups in local areas. Blood agglutination test antigens, as well as vaccines, had not been standardized nor tested for effectiveness. It was soon realized that standardization of testing, vaccinating, and eradication procedures were badly needed. As a result of industry demands, and much research conducted by the Department and State institutions, a National brucellosis eradication program to be conducted in cooperation with individual States, was initiated on July 1, 1934. The initial program involved blood testing, usually on a voluntary basis, with slaughter of infected animals. Laws, regulations, and guidelines were formulated on a State and National level to reduce the spread of brucellosis in interstate channels of trade. In 1934, 33 States already required negative blood serum agglutination tests on all adult cattle entering their respective areas.

Early History and Procedures Development

During the period--1934 to 1940--much progress was made in reducing infection in individual herds. By eliminating known diseased animals and restricting their movements in trade channels, the advantages of an

organized approach to the industry's problem was recognized. However, during the same period, leaders in the livestock industry, as well as State and Federal animal disease eradication officials, realized that elimination of reactors on a voluntary herd participation basis was not the complete answer. Lasting benefits on an area basis had seldom been realized because of lack of participation on the part of neighboring areas. All too frequently, brucellosis again gained entrance into herds formerly freed of the disease.

In 1941, Brucella abortus vaccine, Strain 19, developed by Department scientists, was introduced as a part of the cooperative State-Federal brucellosis eradication program. A team of United States Department of Agriculture scientists had begun research in the early 1900's to develop a satisfactory vaccine for increasing the resistance of cattle against brucellosis. It required many years of laboratory trials and field studies to find and assure a reasonably effective, safe, and stable product. In 1941, 39 States adopted official calfhood vaccination as an adjunct to their cooperative brucellosis eradication programs. Some calves were being vaccinated in the remaining States, but not within the official framework of their programs. Research workers reported that the vaccine, when properly administered, gave a substantial measure of resistance against brucellosis, but it would not provide complete protection against severe exposure to the disease. This has been demonstrated numerous times through research, field experience, and surveys conducted over the years.

Vaccination of calves may mask the disease, in that clinical signs and symptoms are not often seen in vaccinated animals which contract the disease. This leads livestock owners to believe that animals which become infected in spite of proper vaccination, do not have brucellosis. Although infected vaccinated animals may not exhibit symptoms of brucellosis, they may discharge the organism and pose a threat to all susceptible animals with which they come in contact.

North Carolina, in 1941, became the first State to achieve Modified Certified Brucellosis Area status by reducing the disease to not more than' one percent of the cattle and five percent of the herds. The North Carolina

Livestock industry, in cooperation with State and Federal animal disease eradication officials, reached this goal without resorting to calfhood vaccination. However, vaccine is now being employed to a limited extent in selected herds and areas.

The brucellosis milk ring test (BRT) was incorporated into the brucellosis eradication program in 1952. The value of this procedure was proved through many years of research and field trials. It provides a simple and highly effective means of detecting dairy herds having brucellosis. Through the cooperation of the dairy industry, milk samples are collected at receiving stations (milk plants) and identified according to producer. The ring test is conducted on the samples at a central laboratory. Herds with suspicious milk ring tests are then blood tested to find and eliminate infected animals. This method of locating infected herds has eliminated much costly "down-the-road" blood testing of dairy herds and, at the same time, greatly increased the effectiveness of the eradication program. Not only does this permit program funds to be used more effectively, but the dairymen are not faced with the problem of costly and frequent handling of their cattle for blood testing. Herds consistently negative to the BRT are recognized as being free of brucellosis, and are credited toward certification and recertification of counties.

In 1959, market cattle testing (MCT) was initiated as a part of the eradication program. This is a screening procedure for beef herds which parallels and complements brucellosis milk ring testing of dairy herds. The MCT provides a means of detecting infected beef herds by tracing to herds of origin, blood test reactors disclosed at livestock markets and slaughter establishments. The blood samples are usually collected at the slaughter establishments. The MCT program also includes blood testing breeding cattle

returning to farms from livestock markets and other markets. Slaughter-type animals are marked for identification by placing a numbered tag on the back, or are otherwise positively identified according to State, county and owner. Some of the backtagging is also done at ranches and concentration points. Not only does the MCT facilitate eradication, but it eliminates expensive roundups and tests of negative beef herds at the farms and ranches for purposes of qualifying areas for certification and recertification. Adoption of the MCT was proposed and supported by the beef cattle industry. MCT provides continued brucellosis surveillance of herds without frequent assembling of the cattle.

State and Federal costs in carrying out the BRT and MCT are but a fraction of the monies which would be needed to test all herds on the home premises. All States are participating in one or more phases of MCT. Of the animals identified by the MCT backtag showing infection at markets during fiscal year 1963, 96 percent could be traced to herds of origin. The operation of the MCT program is illustrated in Figure 1.

An intensified "problem herd" program became a part of the brucellosis eradication effort in 1959. This program deals with the very small percentage of herds which do not quickly respond to standard eradication procedures. A detailed study of each "problem herd" is carried out by a specially trained veterinary epidemiologist. The value and need for such a program in herds exhibiting persistent evidence of infection was widely recognized.

A battery of useful supplemental tests is available and may be conducted by or under the direction of the epidemiologist, depending on specific needs within each herd, in order to disclose the last vestiges of infection. This procedure, when incorporated into the total eradication program, assures the industry of completely eliminating brucellosis in livestock. There are 22 States currently conducting the "problem herd" program (Figure 2).

The question as to whether or not brucellosis occurs in wildlife, (deer, antelope, elk, etc.) was of concern to various groups. State and Federal disease eradication officials were aware of the need to investigate this possibility, because if the disease was prevalent in wildlife, it could complicate the eradication program in domestic livestock. C. L. Whitehead, and J. P. Newman, of Michigan, in cooperation with the Michigan Department of Conservation, conducted some of the initial work in this regard. In 1958, these workers reported that over 900 head of white-tailed deer had been tested, and that all were negative to the brucellosis blood test.

In their report of 1955, Steen, et al, cited negative findings in Ohio and Minnesota wildlife; reported one reactor among 436 wild animals tested in North Dakota; and no evidence of brucellosis among 936 white-tailed deer tested in Missouri. Wedman, et al, in 1957, reported one reactor among 179 blood samples taken from deer in Minnesota. Reynolds and Smith, in 1958, found no reactors in over 400 deer tested in Massachusetts. The 1958 report on the Southeastern cooperative deer disease study included one reactor among 403 samples collected from deer in ten Southeastern States. Many blood samples were collected from deer killed in Georgia during the 1962 hunting season in an area where cattle owners reported frequent comingling of deer with herds of cattle in which outbreaks of brucellosis had recently occurred; all tests were negative. Similar work has been carried out in the Western States, involving antelope, elk, and other wild animals, and the evidence is that brucellosis does not tend to establish itself in these species of wildlife. Therefore, they do not constitute a problem in the brucellosis eradication program.

Bison have not been overlooked as a possible reservoir of brucellosis. In 1962, a national census of bison was conducted by the Department, disclosing 397 herds comprised of about 12,000 bison located in 47 States.

Currently, there are 13 herds containing about 6,000 bison in which brucellosis is known to exist. The brucellosis status of the remaining herds has not yet been determined. All herds of bison are being placed under surveillance. A regulation has been proposed which is designed to control interstate movements of bison with respect to brucellosis and to encourage eventual eradication of the disease.

Uniform Methods and Rules

As early as the mid-1930's it was generally recognized that brucellosis in livestock was not solely a local or State problem, but one of national significance. As a result, livestock sanitary officials of the Department and cooperating States developed and adopted uniform guidelines for carrying out the eradication program. In 1947, the Uniform Methods and Rules for the eradication of brucellosis were formulated by the United States Livestock Sanitary Association (USLSA), an organization of livestock producers, State and Federal livestock sanitary officials, and others. These were approved by the Department of Agriculture.

It has often been brought out in USLSA reports that brucellosis is not confined to the bovine species alone; therefore, total eradication will not be attained until a uniform, coordinated, and intensified effort is made to eradicate the disease in all affected species. Recommendations are submitted annually by the livestock industry, organizations such as the National Brucellosis Committee, and others, to revise portions of the Uniform Methods and Rules as needed to advance or expedite eradication. These are considered by the USLSA and, if desirable, the recommendations are adopted as a part of the Uniform Methods and Rules. Upon approval by the Department, they become a part of the official cooperative program.

These Uniform Methods and Rules are not, and never have been, inflexible standards. They are subject to alteration to meet the needs of the livestock industry and to achieve objectives of the program. In reviewing the Uniform Methods and Rules from 1947 to 1963, it is obvious that improved disease eradication measures have kept pace with new knowledge developed through research and changing livestock management practices.

National Brucellosis Committee

The first meeting of the National Brucellosis Committee (NBC) was held in Chicago, Illinois, on May 10, 1949. The purpose of this Committee is to promote, aid, and engage in educational activities and encourage scientific research in the field of brucellosis eradication before State legislatures and the Congress. The NBC holds annual meetings and publishes its proceedings which include, but are not limited to, annual progress reports, subcommittee reports on education and information, research, procedures, finance and public health. The members of this Committee represent many organizations within the livestock industry and other concerned groups as follows: Association of Land Grant Colleges and Universities; American Agriculture Editors Association; Livestock Conservation, Inc.; Federal Extension Service; American Angus Association; American Farm Bureau Federation; American Meat Institute; American Medical Association; American National Cattlemen's Association; American Veterinary Medical Association; National Association of State Departments of Agriculture; National Independent Meat Packers Association; National Livestock and Meat Board; National Milk Producers Federation; National Swine Growers' Council; Purebred Dairy Cattle Association; Texas and Southwestern Cattle Raisers Association; United States Livestock Sanitary Association; and the United States Public Health Service. A few years after the Committee was formed,

it became a part of Livestock Conservation, Incorporated, where it continues to carry out its original responsibilities to the industry. The accomplishments of this Committee since its inception have been numerous, but of greatest significance are its roles in the field of education and coordinating State and national efforts toward brucellosis eradication.

ECONOMIC AND PUBLIC HEALTH ASPECTS OF BRUCELLOSIS

Requests for a brucellosis eradication program originated within the livestock industry, primarily from cattle producers experiencing severe economic losses. Losses to the cattle industry were high, but losses to the entire U. S. economy, incurred as a result of brucellosis, were much greater. Figure 3 indicates financial losses to the livestock industry in 1947, 1954, and 1963 resulting from abortions, sterility, milk losses in dairy animals, and cost of animals needed to replace the affected animals. It must be acknowledged that not only do livestock owners sustain economic losses from brucellosis, but allied industries and the public share a depressed economy. Figure 4 depicts the gross economic losses in 1947, 1954, and 1963. The figures demonstrate the losses incurred by all segments of the livestock industry, allied industries, and the public.

This Nation has long been noted for its high per capita consumption of meat and dairy products, and its utilization of animal by-products in various allied industries. Therefore, estimated losses from brucellosis must include the entire economy. It is gratifying to note that economic losses in 1963 were reduced by 80 percent compared with 1947. It is estimated that without an active cooperative State-Federal brucellosis eradication program during the intervening 15 years, the economic losses would have increased materially, probably amounting to over 120 million dollars annually. This estimate is based upon actual increases in numbers of outbreaks during World War II, when the eradication effort almost ceased. (Figure 5)

It has long been recognized that the problem of eliminating brucellosis of man depends upon eradicating the infection in animals, because contact with infected animals or their products is the only source of the disease in man. Prior to local ordinances prohibiting sale of raw milk, this was a common source of exposure to the consuming public because of milk of infected animals usually contains billions of the causative organism. Proper pasteurization kills the bacteria, but milk containing the dead organisms is not a completely wholesome product. Sensitized individuals sometimes suffer serious allergic reactions as a result of consuming killed Brucella organisms.

Millions of persons risk exposure to infected animals on farms and in commercial channels every year. Figure 6 indicates the number of cases of human brucellosis reported to the Public Health Service, U. S. Department of Health, Education and Welfare, each year from 1947 through 1962. The incidence of human brucellosis has decreased more than 93 percent since 1947. The decreasing number of reported human cases parallels the reduction of brucellosis in cattle blood tested during the same period (Figure 7). Brucellosis in cattle blood tested declined from 4.5 percent in 1947 to 1.2 percent in fiscal year 1963. It is agreed that eradication of human brucellosis depends on eliminating animal reservoirs of infection.

IMPLEMENTATION OF PROGRAMS

Federal-State Cooperation

From the very beginning of the State-Federal brucellosis eradication program in 1934, the individual States enacted laws and promulgated regulations to further brucellosis eradication. State legislation complements the national effort by regulating movements of livestock into and within the confines of their respective States. A law enacted by the Congress, effective in fiscal year 1963, limited Department support of the cooperative brucellosis eradication program in each State to not more than 60 percent of the funds expended for brucellosis eradication. This curtailed eradication efforts in several States where past Federal expenditures had exceeded 60 percent, and now limits activities in others.

Education and Information

The Department, with the assistance of National, State, and County brucellosis committees and Extension Service, has continually provided the livestock industry with factual information relative to brucellosis eradication. The material published has been based upon research, field studies, and experience gained through the years in carrying on the program. Documented information pertaining to brucellosis and the eradication program has been distributed to all segments of the livestock industry. That the informed industry supports the program, is evident in that 82 percent of the counties in the United States had attained Modified Certified Brucellosis Area status by the close of fiscal year 1963.

In disseminating information to the industry, the following media are utilized: audio-visual aids such as films, radio and television tapes; printed material such as program leaflets, displays, and exhibits; and press releases. All significant achievements in the brucellosis eradication program are given national publicity through prepared press releases. In 1962, detailed reports were furnished to 250 selected farm magazines. Special radio tapes were prepared by both State and national authorities and released to about 400 radio stations from coast to coast. Video tapes, films, and other materials were prepared and released through Department facilities to 195 television stations having a viewing potential of nearly ten million people. The information disseminated included, but was not limited to, livestock management practices pertinent to the eradication program, market cattle testing, "problem herd" program, the role of the veterinary epidemiologists, etc. In cooperation with the Agriculture Education Branch, U. S. Office of Education, the Department is preparing teaching aids defining the present status of the brucellosis eradication program and future objectives. These will be used by vocational agriculture instructors in high schools throughout the nation.

In addition to the above material used in releasing current information, the Department has the following material available upon request from the livestock industry and other interested groups: Radio tapes, Television tapes, Films, Program aids, Displays, and Exhibits. This material is available through university libraries, Extension Service or ADE Division Stations in all States.

The Animal Disease Eradication Division of the Agricultural Research Service, USDA, conducts the Federal aspects of the brucellosis eradication program. The Act of 1884 and subsequent Acts authorize the Department to

cooperate with the individual States under Memorandums of Understanding outlining the responsibilities and obligations of both parties. Funds appropriated by the Congress for brucellosis eradication, and those appropriated by State Legislatures for State livestock disease eradication implement eradication measures carried out under authority of State and Federal laws, regulations, according to guidelines established in the Uniform Methods and Rules.

When livestock owners indicate an interest, the first action taken by the Division and cooperating State officials in initiating a new county brucellosis eradication program in most States is to hold local county meetings. The local and county meetings are arranged through cooperation of the Extension Service and livestock organizations. The purpose of each meeting is to explain the program to all livestock producers, outlining benefits and explaining laws, regulations, and procedures pertaining to eradication. Past accomplishments in brucellosis eradication could not have been possible without the support of the majority of livestock owners and all other segments of the livestock industry.

Background

The field activities of the program are conducted along the following guidelines:

In a few areas which surveys have shown the cattle to be heavily infected, a preparatory program of calf vaccination is inaugurated if desired by the cattlemen. However, most areas now begin eradication of the disease by using the brucellosis ring test and market cattle tests as screening measures to establish the disease status of herds in the area. Herds shown by these serum tests to be free of brucellosis are so credited, while those which are indicated as probably infected are subjected to an individual blood test of each one of the animals in the herd with the

exception of steers, and vaccinated heifers less than 30 months of age which are not yet fresh or springing. If the owner desires, any heifer calves between 4 and 8 months old may be vaccinated at this time.

Any animals found to be reactors to the blood test are identified by a "B" brand and promptly sent to slaughter. The herd is placed under quarantine. Only animals going to slaughter may be moved from the herd. The premises is thoroughly cleaned and disinfected to prevent any further exposure to the herd from the environs. The herd is subjected to a retest and if no additional infected animals are disclosed, the herd is released from quarantine.

Movement of the infected animals to slaughter is accomplished with a permit which alerts the transportation agencies and market operators that the animal is infected and any vehicles or pens used in handling the infected animal must be cleaned and disinfected.

The quarantines placed on the herd are under the authority of State laws or regulations. They are supported, however, by Federal regulations which are designed to prevent infection of herds in certified areas. (Figure 8)

Calf vaccination in these areas is continued through regular notification by county agents or direct from the State or Federal office to the effect that vaccination of heifer calves is desirable and is available.

See Figure 14.

Regularly employed Federal and State veterinarians assist in the program and supervise the field activities of others. Under their supervision, private practicing accredited veterinarians provide specific services as provided in State or Federal contracts. The practitioners collect blood samples from cattle and vaccinate calves at farms, livestock markets and concentration points for established fees. Thus, a client-practitioner relationship, desired and supported by industry, is maintained.

With the private practitioner's cooperation and assistance, the widespread operations of the program are being successfully carried out.

Regularly employed technicians, both State and Federal, carry out the other activities of the program under veterinary supervision. These technicians inspect livestock and assist owners in complying with State and Federal laws and regulations designed to halt the spread of brucellosis. Interstate regulations promulgated by the Department and administered by the ADR Division are designed to prevent the spread of brucellosis in cattle. With 82 percent of the counties having attained Modified Certified Status and approaching final eradication, control of infected animals becomes increasingly important. Technicians periodically inspect cooperating livestock markets and slaughtering establishments to assure the application of sanitary measures. They also supervise the proper marketing of animals affected with brucellosis and service State quarantines.

For uniformity in brucellosis testing procedures, cooperative State-Federal laboratories were established. The laboratories employ specially trained serologists and technicians who work under veterinary supervision. Their primary technical responsibilities are to conduct the standard blood sero-agglutination tests for brucellosis. Many conduct additional tests relative to the "problem herd" program.

Brucella abortus Strain 19 vaccine is produced under Departmental supervision, assuring a safe and potent product. Quality control is also carried out at State-Federal laboratories on samples of each serial lot of commercially produced vaccine received.

The Department supervises the production by private industry of standardized test antigens and produces antigens for tube, plate, milk ring, and supplemental tests used in the official program.

Through epidemiological studies of brucellosis "problem herds", new techniques have been developed to assure eradication of the disease in all herds. By the application of diagnostic procedures now available, coupled with proper livestock management, brucellosis can be eliminated from all infected herds.

The Department is cooperating with universities to train selected veterinarians in the advanced techniques and principles of brucellosis eradication. These brucellosis eradication specialists, strategically located throughout the nation, provide service for "problem herds". They detect and eliminate infected animals which occasionally do not respond to the usual tests. This is expediting eradication wherever States have requested the service.

The Department conducts and encourages research on problems relating to brucellosis eradication.

RESEARCH - BRUCELLA ABORTUS STRAIN 19 VACCINE

In 1897, when Professor Bernhard Bang and his associate, Stribolt, announced the discovery of the bacterial agent causing brucellosis in cattle, they suggested the possibility of artificial immunization as a means of combating it. At first they tried vaccines containing killed organisms, but without success. However, vaccines containing living cells showed promise. Most research on vaccines from that time forward has been carried out using live cultures of various Brucella strains. Vaccination has received much attention from many research people abroad, as well as in this country. In 1917, the United States Bureau of Animal Industry began research on vaccination against the disease (Buck and Creech). Prior to this, very little work had been done to determine the virulence of many Brucella abortus strains used in preparing vaccines. The problem confronting research was to produce a vaccine that would induce increased resistance without causing the disease. In 1925, vaccination experiments conducted by Hart and Traum were encouraging as were similar findings of Bureau of Animal Industry scientists, but it was found that vaccinated animals became spreaders of the infectious organisms used. During this period, Dr. I. F. Huddleson of Michigan State College, and other investigators, reported comparable results. W. E. Cotton and J. M. Buck at USDA's Beltsville Experiment Station, in conducting controlled experiments using vaccine prepared from Brucella abortus Strains 11, 19, 484, found Strain 19 to be the most promising. The Brucella abortus Strain 19 organism had been under artificial cultivation since 1923 and was more pathogenic for guinea pigs than Strain 11, but

less than Strain 484. In 1928, they began a series of experiments in calfhood vaccination during which Strain 19 Brucella abortus proved to be an organism of low virulence. As a result of their research, numerous studies were initiated in 1936, involving several States, to determine the effectiveness of Strain 19 vaccination under field conditions.

Continued research has been carried out to determine the advantages and limitations of Strain 19 vaccine by C. A. Manthei, C. K. Mingle, R. W. Carter, G. Lambert, E. R. Goode, T. E. Amerault, of ARS; H. L. Gilman and D. E. Hughes of New York; I. F. Huddleson, Michigan; Nelson King, Ohio; and numerous other recognized scientists in this country and abroad.

Controlled experiments were conducted in California, Illinois, Ohio and Beltsville to determine the protective value of Brucella abortus Strain 19 vaccine. The combined data indicate that 64 percent of the cattle were satisfactorily protected against brucellosis under the conditions of exposure employed in the experiments. In addition, the following data and conclusions have been compiled from the numerous controlled studies: (1) resistance produced with Brucella abortus Strain 19 vaccine is relative, rather than absolute; (2) the apparent effectiveness of Brucella abortus Strain 19 vaccination increases as the degree of exposure decreases; (3) resistance of vaccinated cattle does not decrease with age; (4) vaccinated cattle that become infected generally do not show clinical signs of brucellosis; (5) approximately 65 percent of calfhood vaccinated cattle will have acquired satisfactory protection against challenge; (6) Brucella abortus Strain 19 vaccine, when used alone, will control brucellosis up to a point, but has not eradicated the disease from many infected herds; (7) Strain 19 vaccine is incapable of curing brucellosis, and it does not alter the course of the disease when injected into affected animals.

In 1951, C. A. Manthei, C. K. Mingle, and R. W. Carter, of the Department, reported their research on the duration of resistance induced in cattle with Brucella abortus Strain 19 vaccine. Results indicated that: (1) resistance induced by vaccine does not decrease with time, and (2) no difference in resistance was observed in animals vaccinated as calves and those vaccinated at 2 years of age when challenged in the third pregnancy.

The effect of age on resistance and retention of blood sero-agglutinin titers in cattle vaccinated with Brucella abortus Strain 19 vaccine was reported by N. B. King and Norman Frank, Ohio, in July 1961. As a result of their work, the authors concluded that vaccinating calves at 3 months of age produced resistance at least equal to that induced in calves vaccinated at 6 and 9 months of age, and that agglutinin titers do not persist in the younger animals as in the case in many animals vaccinated at more advanced ages.

Veterinary epidemiologists conducting work in "problem herds" have continued investigations in connection with Brucella abortus Strain 19 vaccination. Since 1959, they have isolated field strains of Brucella abortus from 345 animals, of which 197 (57 percent) were official vaccines. This again demonstrates the limitations of Brucella abortus Strain 19 vaccine, in that eradication of brucellosis cannot be accomplished by vaccination alone.

A minority of livestock owners evidently do not recognize the limitations of Brucella abortus Strain 19 vaccine. The Department, State livestock sanitary officials, and numerous segments of the livestock industry were well aware of the limitations of Strain 19 vaccine as early as 1940. Subsequent research and field studies have invariably substantiated these facts; the limitations of Brucella Strain 19 vaccine have been fully documented. The following research trials and field studies are presented:

FIELD STUDIES - BRUCELLA ABORTUS STRAIN 19 VACCINE

Following is a summary of a brucellosis vaccination survey conducted on Montana beef cattle during the period 1952 to 1958. This detailed report was published in April 1959 (ARS Publication 91-12). All data was submitted by Montana livestock sanitary officials and their staff in cooperation with the Animal Disease Eradication Division.

At the time of the initial area brucellosis certification test in herds of the beef breeds in Montana, data were assembled for the purpose of evaluating the effect of vaccination on infection rates for both herds and cattle. In all, 951,014 cattle were tested in 21,418 herds. There were 255,757 animals (26.89 percent) which had been vaccinated against brucellosis, while 695,257 (73.11 percent) had not. Of the total 21,418 herds, 2,349 herds contained reactors.

Data analyzed on the basis of percentage of animals vaccinated within herds, and comparisons of vaccinated and nonvaccinated populations, provided the following facts:

1. The herd infection rate was only 23 percent lower in those herds in which all animals were vaccinated than it was in those herds in which none of the cattle was vaccinated.
2. The infection rate within the entire vaccinated cattle population was approximately 80 percent lower than that within the entire nonvaccinated population.
3. Vaccinal titers were not a primary cause for the presence of suspect animals in herds containing suspects, but no reactors.

4. Suspects occurred 36 percent less frequently within the vaccinated population than within the nonvaccinated population.
5. In partially vaccinated infected herds, brucellosis occurred 65 percent less frequently within the vaccinated population than it did within the nonvaccinated population. This, then, is a protection rate of 65 percent in the face of known exposure. (In explanation, the protection afforded by vaccination in the face of known exposure is only 60 to 65 percent. The vaccinated animals which are still susceptible, being evenly distributed throughout the entire herd population, serve to perpetuate the disease among vaccinated populations. They pose a threat of exposure to nonvaccinated contacts as well.)
6. In infected herds in which all animals were vaccinated, brucellosis occurred 60 percent less frequently than it did among nonvaccinated cattle in partially vaccinated infected herds.
7. The relative protection afforded by Strain 19 vaccine did not influence the rate of infection within nonvaccinated populations in infected herds, regardless of the percent of animals vaccinated.
8. It must be concluded that vaccination alone cannot be expected to eradicate brucellosis nor to free the majority of infected herds from the disease. Infected animals must be identified and eliminated.

9. Vaccination is very useful in building the resistance of most susceptible animals against brucellosis, but its limitations must be recognized.

At the suggestion of the American National Cattlemen's Association, the Animal Disease Eradication Division initiated another vaccination survey on March 1, 1961. This survey is being conducted to determine the efficacy of Strain 19 vaccine in limiting the spread of brucellosis within infected herds and throughout certified range and semi-range counties. Up to May 1, 1963, data for this study had been submitted from 145 counties in 15 States. The data are assembled at the time county recertifications are requested. The States involved are:

Arizona	Mississippi	Oregon
Arkansas	Montana	South Dakota
Colorado	Nevada	Utah
Florida	New Mexico	Washington
Idaho	North Dakota	Wyoming

The animal population of the 145 counties is 4,090,961 cattle in 108,976 herds. During three-year county certification periods, 37,557 herds were blood or milk ring tested, representing 913,001 cattle. This testing involved 34.5 percent of the herds and 22.3 percent of the cattle. Brucellosis was identified in 3.8 percent of the herds, and 0.68 percent of the cattle.

Of the 83,293 exposed cattle in the infected herds, 26,213 or 31.5 percent, had been vaccinated. Of these, 558, or 2.13 percent, were infected. Of the 57,080 nonvaccinated animals among the known exposed population, 4,847, or 8.49 percent, were infected. By calculation, the apparent protection afforded by vaccination in the infected herds was determined to be 74.9 percent. When broken down into beef and dairy breeds, the protection from vaccination in known infected herds was 81.6 percent and 69.7 percent, respectively. This significant difference can be explained,

in part at least, by variations in the concentration of populations in these herds and differences in herd management.

In the case of 585 infected beef herds which contained both vaccinated and nonvaccinated cattle, only 1.3 percent of the 18,332 vaccinated animals were infected, while 7.2 percent of the 37,615 nonvaccinated animals in these same herds were reactors. Brucellosis was found also in 18 beef herds in which all animals had been vaccinated; 24 infected animals were disclosed out of the 1,052 cattle contained in these herds.

These data reflect the serviceable but limited protection afforded by Strain 19 vaccination in both beef and dairy herds. They also indicate the relationship between vaccinal protection and the degree of exposure to which vaccines are subjected.

PROGRESS AND GOALS

The brucellosis program is moving through a series of methodical, ever-advancing steps toward final eradication, incorporating all useful and effective procedures. To illustrate, in the 1930's when the Department was first authorized to cooperate with individual States in carrying out a brucellosis eradication program, blood testing of cattle, slaughter of infected animals, and quarantine of infected herds were tools used. Figure 9 illustrates the progress from 1935 through 1941, using only these procedures. One State - North Carolina - achieved Modified Certified Brucellosis Area status during the early years (1941).

Although Brucella Strain 19 vaccine became available by 1942, decreased testing activities because of personnel shortages during World War II permitted the disease to increase significantly (Figure 10). Not until after World War II was further progress evident.

In 1947, the Uniform Methods and Rules were first published, thus providing guidelines and minimum standards for conducting the brucellosis eradication program. About the same time, field trials were initiated to evaluate the milk ring test (BRT). Antigens were improved and standardized, permitting official adoption of this test by 1952. Immediately, the efficiency of the program increased materially (Figure 11). By 1954, it became apparent to all that adequate procedures were then available to assure eradication, and all activities were multiplied manyfold.

From 1954 through fiscal year 1963, phenomenal progress has been made as indicated in Figure 12. Brucellosis has been reduced by more than 90 percent through extensive use of the BRT, incorporation of the

market cattle testing (MCT) and "problem herd" programs, blood testing, and calf vaccination. BRT and MCT provide the means for locating infected herds on a large scale at minimum expense to the industry and the public by eliminating the costly testing of all herds and complete areas.

The need to establish realistic timetables and goals for nationwide certification and eradication was voiced by both the United States Livestock Sanitary Association and the National Brucellosis Committee. These goals were then established by the ADE Division in 1960. They call for nationwide Modified Certified Brucellosis Area status by 1965, and complete eradication of brucellosis in all susceptible species by 1975.

(Figure 13)

These goals were based on program accomplishments from 1954 to 1960. By stating program goals, the livestock industry and animal disease eradication officials were alerted and encouraged to plan for the final coordinated eradication effort. The goal of eliminating brucellosis is no longer on the distant horizon, but is entirely attainable in the near future. To reach the established goals of certification and eradication, however, the present tendency of some areas to put off or postpone the program must be altered. Lagging areas face increased restrictions in livestock commerce imposed by the certified States, as a means of protecting their animals.

Eradication Versus A Control Program

This nation's livestock industry, in the 1800's established the precedent of not living with animal diseases which can be economically eradicated. This was evidenced by the successful eradication of bovine

contagious pleuropneumonia. Again in the early 1900's as foot-and-mouth disease gained entrance into the United States, eradication, not control, was the answer. This has continued to be the policy of the Nation, as glanders and dourine of horses, vesicular exanthema of swine, Texas cattle fever, and other serious infectious diseases of animals were eradicated. Although minorities voiced opposition and their preference to live with these diseases, the majority of the people in the livestock industry supported the principle of eradication, to the everlasting benefit of this Nation.

Brucellosis is a disease that can be eliminated. This has been done in Norway and Sweden, and in many counties in the United States. By December 31, 1963, 233 counties in 19 States, Puerto Rico and the Virgin Islands had attained Certified Brucellosis-Free status. The entire State of New Hampshire achieved this goal in 1960 and Maine in 1963. (Figure 16).

The great majority of livestock producers has made the final decision to eradicate brucellosis rather than live with such an insidious and costly disease. A small segment of the livestock industry, however, prefers a "vaccination-only" program to control brucellosis. A brucellosis control program based only on vaccination would cost the industry an estimated \$15 million annually, and there would be no hope of eradication. Eradication can be achieved efficiently within the goals established, provided the livestock owners in all remaining nonparticipating areas request and support the program in the near future.

Prospects for Completing Nationwide Modified Certified Brucellosis Area Status by June 1965

Unless the following States increase the scope of their activities, they will not complete modified certified status by the National goal of 1965 (Figure 15) -- Alabama, Florida, Nebraska, Oklahoma, South Dakota, Texas and Wyoming. The following noncertified States have adopted procedures which they believe will assure modified certified status prior to July 1, 1965 -- Alaska, Colorado, Hawaii, Illinois, Iowa, Louisiana, Mississippi, Montana, North Dakota and Ohio.

Specific problems within individual States slowed and, in several instances, almost stopped further expansion of the program. The problems in these States which do not expect to attain modified certified status prior to July 1, 1965, are discussed below.

In Alabama, the high level of infection and slow rate of progress has resulted in the disease breaking out, all too frequently, in areas which have been previously tested. If all counties in the State could be included in preliminary work embracing milk ring and market cattle tests with compulsory testing of infected herds, it would be possible to complete certification prior to the national goal.

In Florida, the Florida Cattlemen's Association objected strenuously to further expansion of area certifications, and was instrumental in blocking the circulation of petitions for area programs after 1959. The Association proposed a program of calf vaccination in lieu of the complete eradication program. It agreed to the establishment of a Statewide market cattle testing program to determine the incidence of brucellosis and its geographic distribution throughout the State. Much information has been accumulated since 1961 which indicates a comparatively high

incidence of brucellosis within the State. Tests of market cattle which originate in the noncertified counties of the State reveal 4.6 percent infection. Almost 1,000 herds, or 13 percent of those represented in market tests, have been determined to be infected. Although the information concerning infected animals is being provided to cattle owners, they have done little to eliminate the disease.

The voluntary free calfhood vaccination program proposed by the Cattlemen's Association and adopted by the State has not been as widely accepted as the Association had anticipated, and repeated editorials have appeared in the magazine, Florida Cattlemen, urging adoption of this procedure. In the face of the failure of the all-out vaccination program and the continued high incidence of brucellosis in the State, it is becoming apparent to an increasing number of livestock owners in Florida that a complete eradication program will be necessary to maintain a successful cattle industry in Florida.

Nebraska has certified all counties that lie within the concentrated farming areas, leaving most of the range areas without an adequate brucellosis eradication program. The "vaccination-only" movement is strong in Nebraska. Therefore, much educational groundwork will be necessary before the entire State will be included in the eradication program.

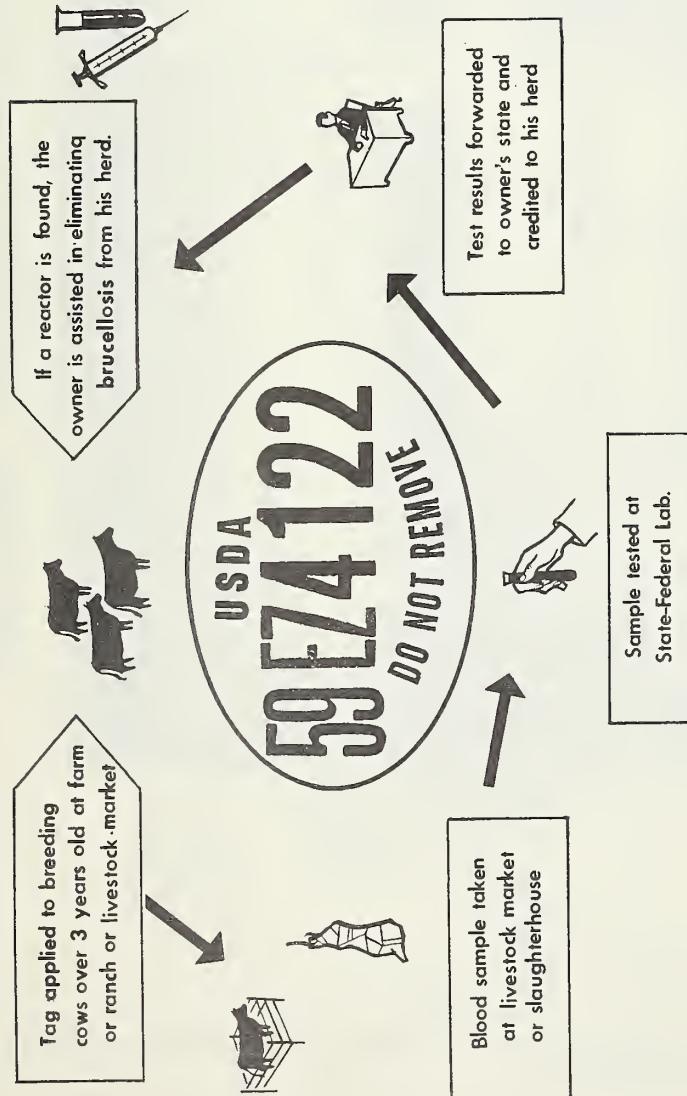
Oklahoma has a relatively high incidence of brucellosis, but complacency has hindered progress in the majority of counties. There is evidence at this time that the market cattle testing program will stimulate interest and progress in this State, but not in time to assure certification by the end of fiscal year 1965.

The majority of cattlemen in South Dakota wish to certify the State, but minority groups in some counties have initiated court action on several occasions to contest the authority of the State Livestock Sanitary Board to test their animals. Limited progress continues in the State as a result of a strengthened animal disease law passed by the 1963 State Legislature, but continued minority protests are expected which will delay the program indefinitely in a number of the range counties.

Texas has been plagued by a late start compared to most States, a very large geographic area, and a great cattle population. Although much progress has been made, the present level of activities will not permit certification of the last counties until 1969. It is hoped that the State authorities will accelerate progress by initiating eradication activities in all counties.

Wyoming has made much progress in the past, with 16 of its 23 counties already certified. Apparently the incidence of the disease has also been reduced to a very low level throughout the State. There are three counties which are now striving for initial certification, leaving only four non-certified counties to adopt area programs. It appears that State laws need to be strengthened and further inducements provided to cattle owners before the entire State can achieve certification.

HOW BACKTAGGING WORKS



U.S. Department of Agriculture

Agricultural Research Service

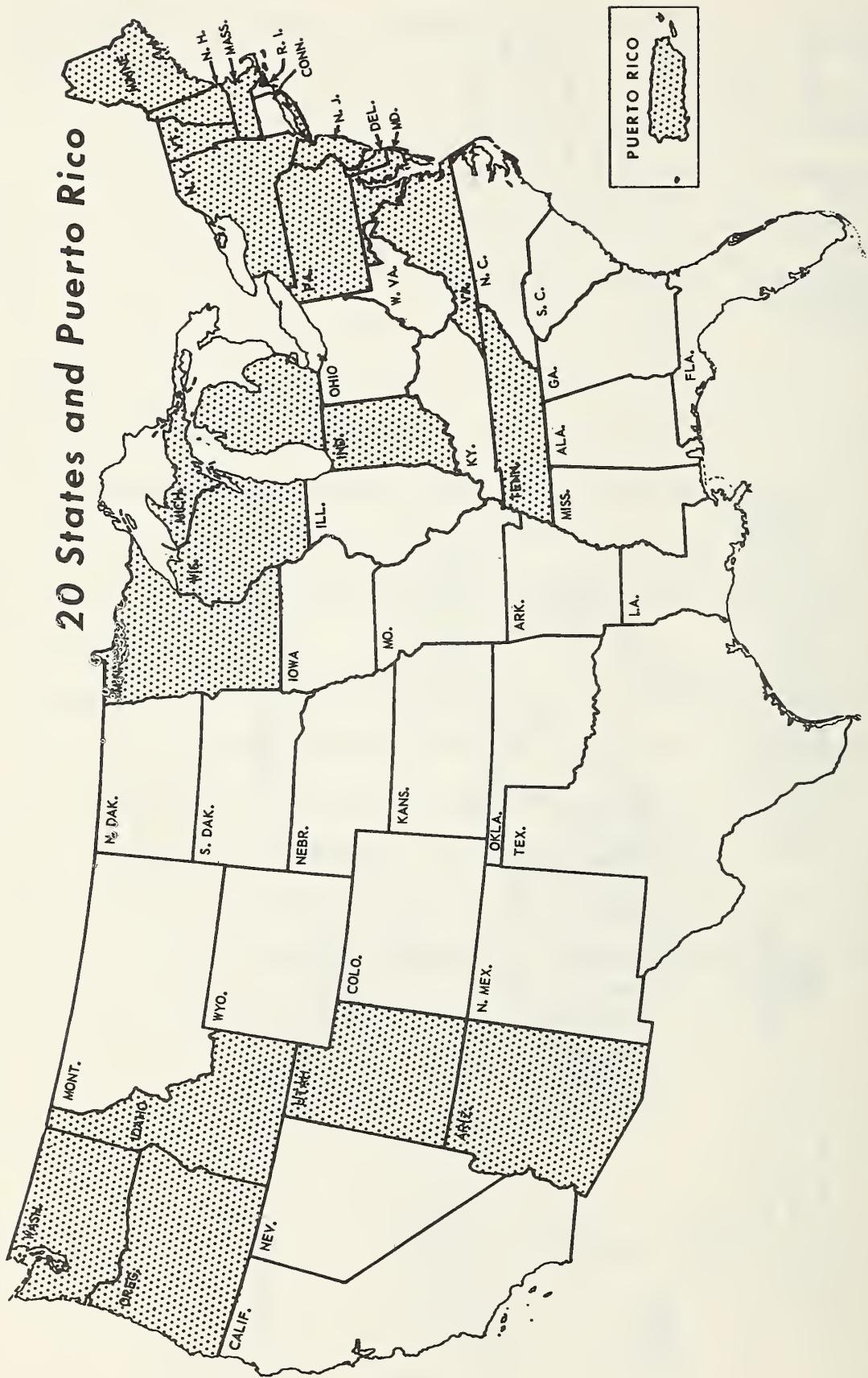
USDA
59 E74122

A tag like this, made of plastic, is cemented to the cow's back as it starts to market. The numbers and letters identify the state, county and the specific herd.

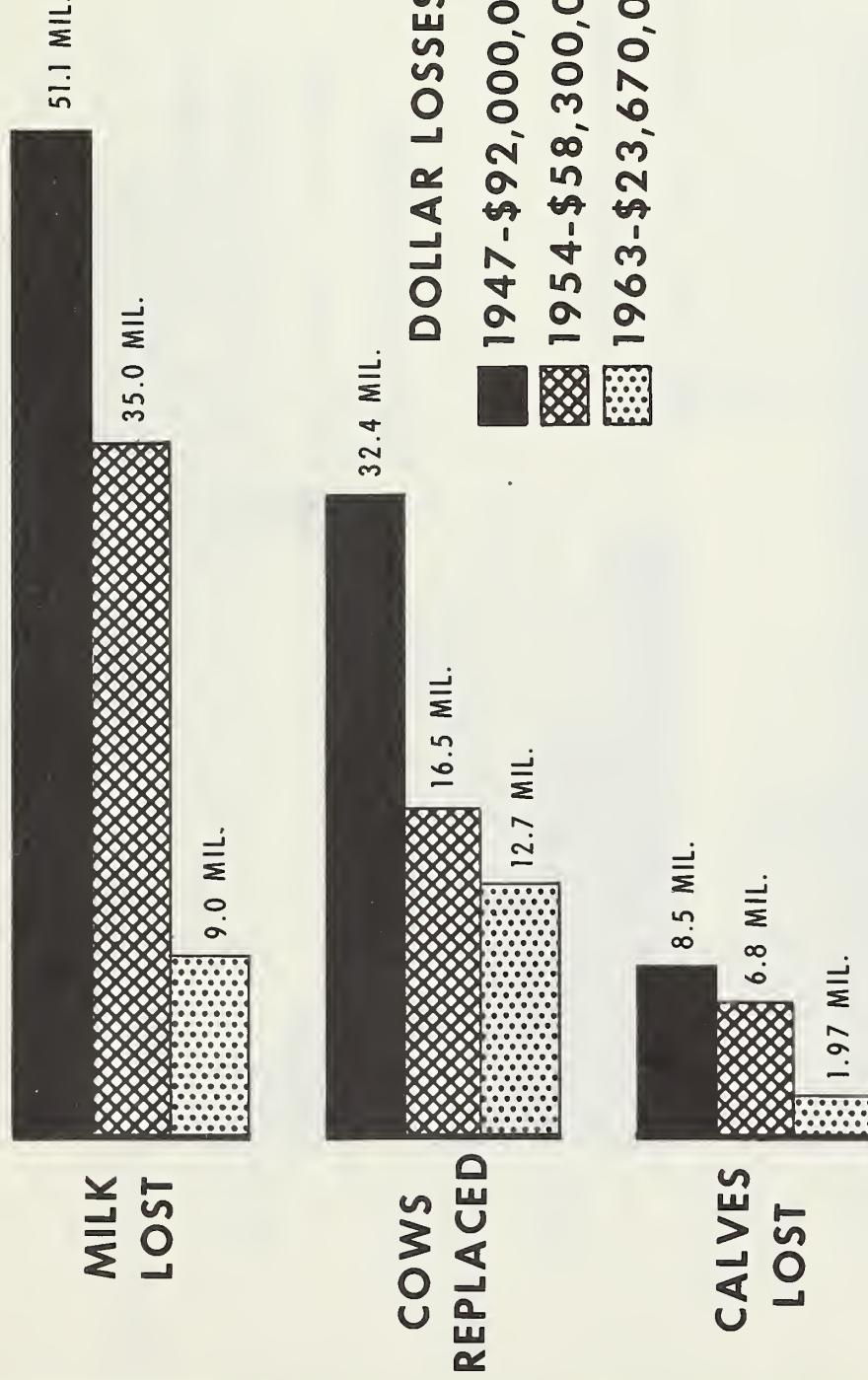
FIGURE 1

States Conducting Brucellosis Problem Herd Work

January 1963



BOVINE BRUCELLOSIS LOSSES



U. S. DEPARTMENT OF AGRICULTURE

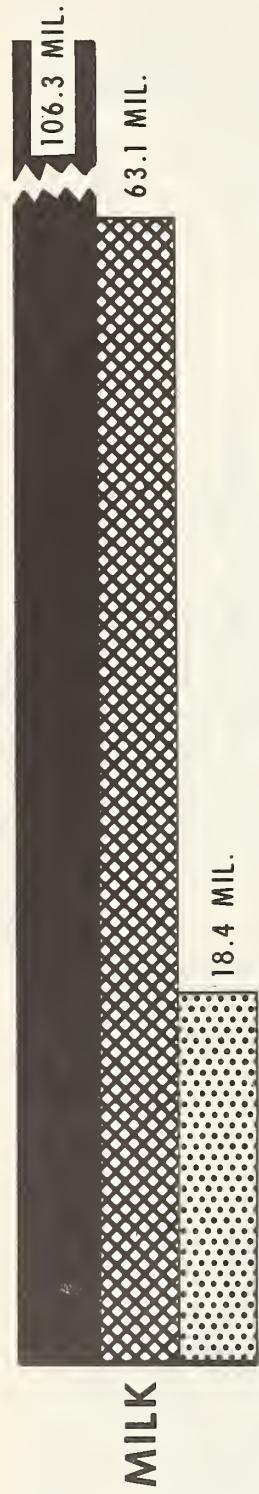
AGRICULTURAL RESEARCH SERVICE

FISCAL YEAR

FIGURE 3

Brucellosis Eradication

GROSS ECONOMIC LOSSES*

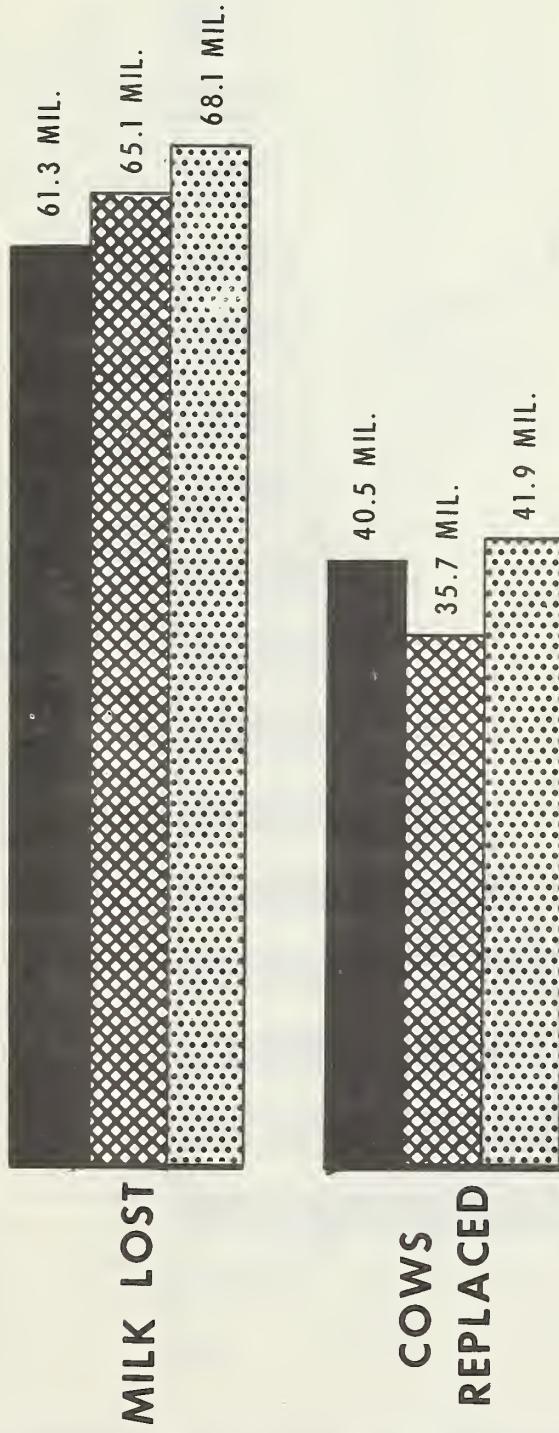


* RETAIL VALUES IN MILLIONS OF DOLLARS.

U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

BRUCELLOSIS LOSSES*



FISCAL YEAR

* 6% INFECTION LEVEL WITH NO ERADICATION PROGRAM.

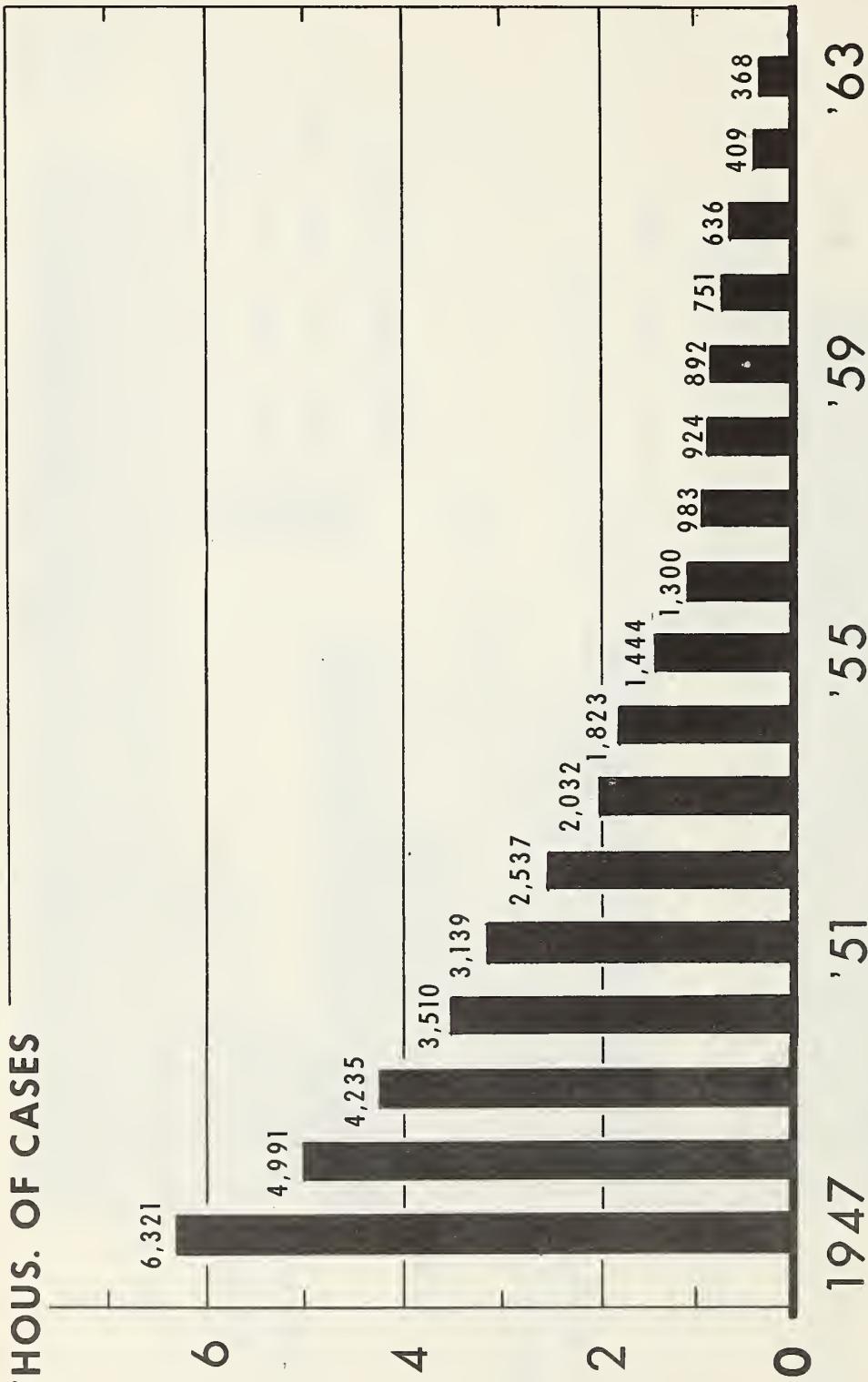
U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

FIGURE 5

REPORTED HUMAN BRUCELLOSIS*

THOUS. OF CASES



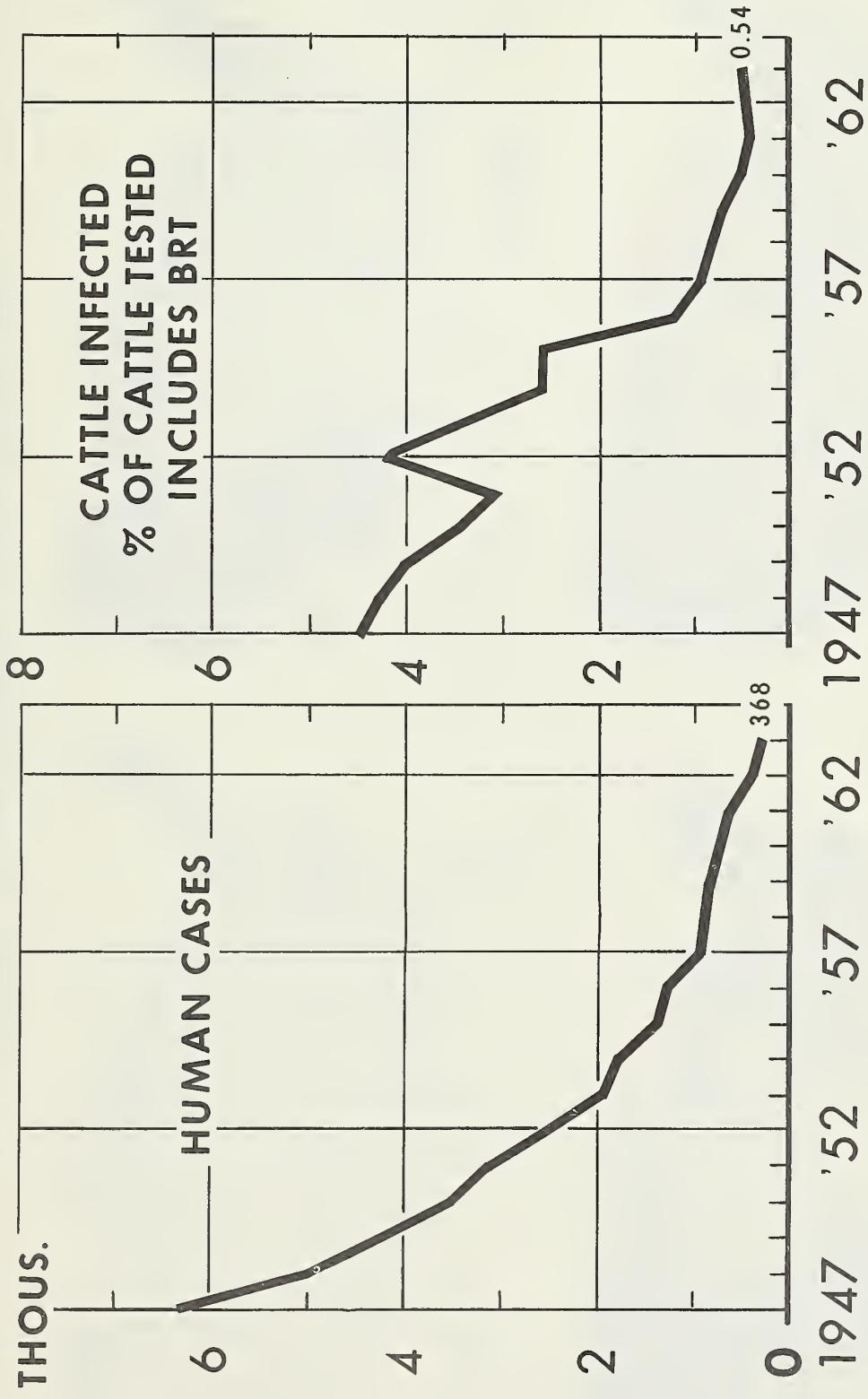
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*1947 TO 1963 PRELIMINARY.

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FIGURE 6

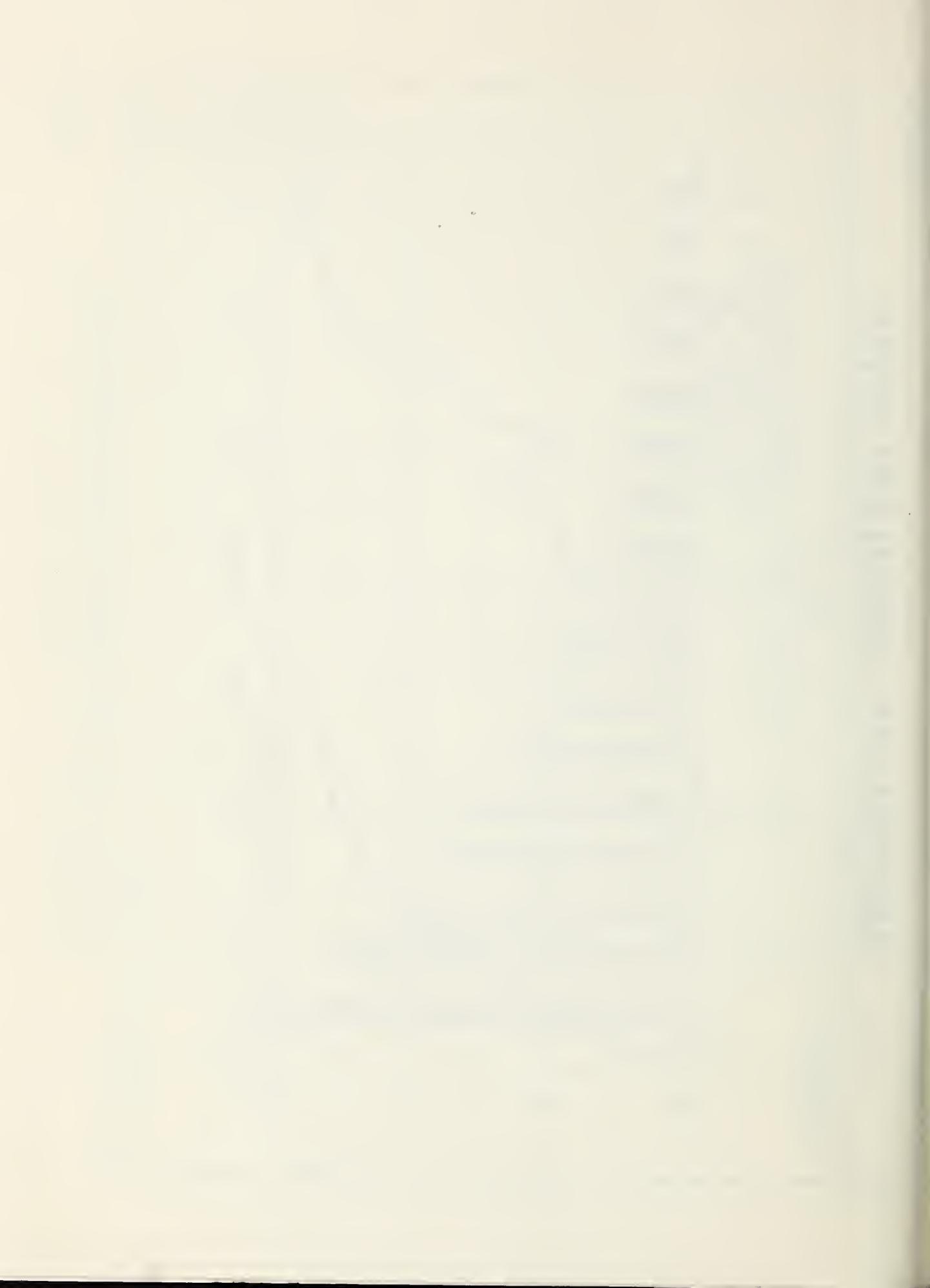
BRUCELLOSIS-UNDULANT FEVER



U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

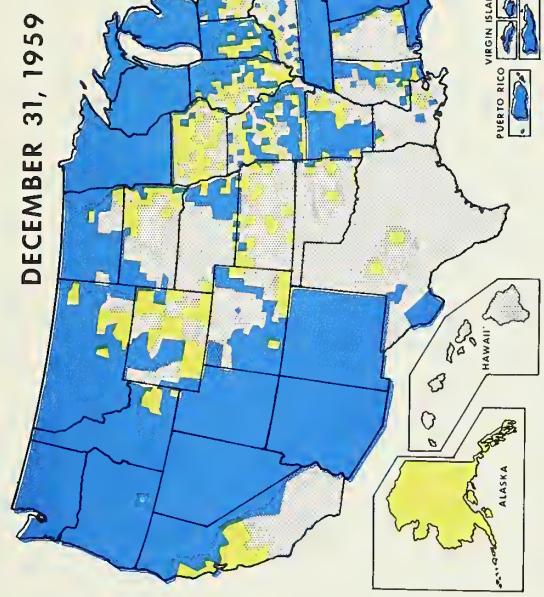
FIGURE 7



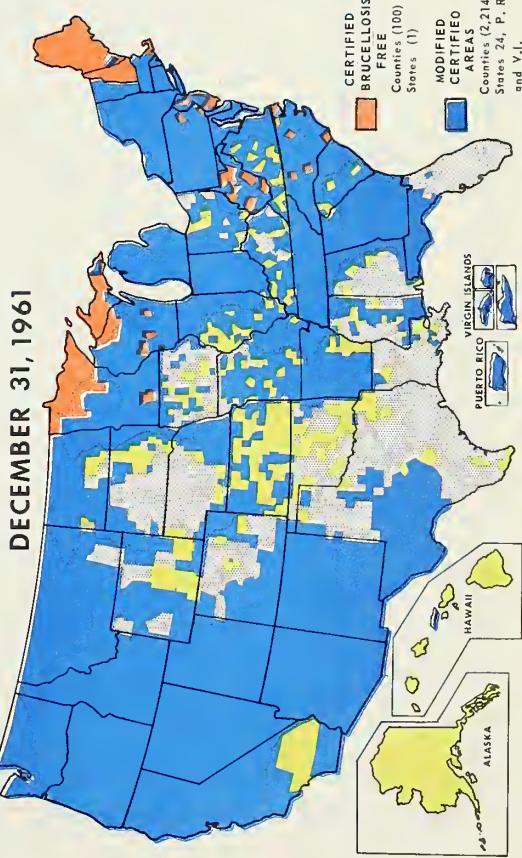
Cooperative State-Federal BRUCELLIOSIS ERADICATION PROGRAM



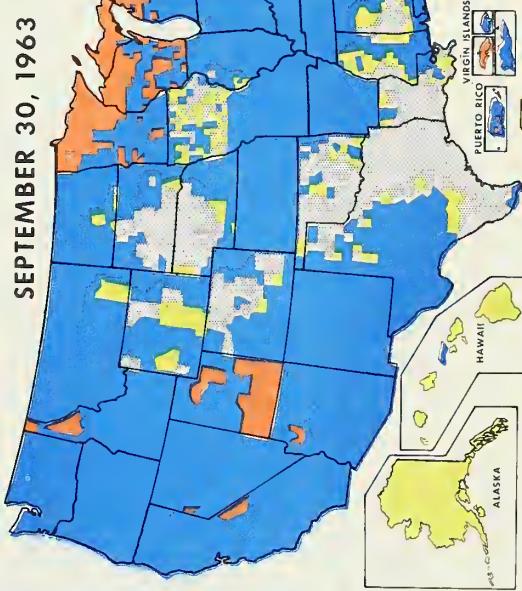
SEPTEMBER 30, 1954



DECEMBER 31, 1959



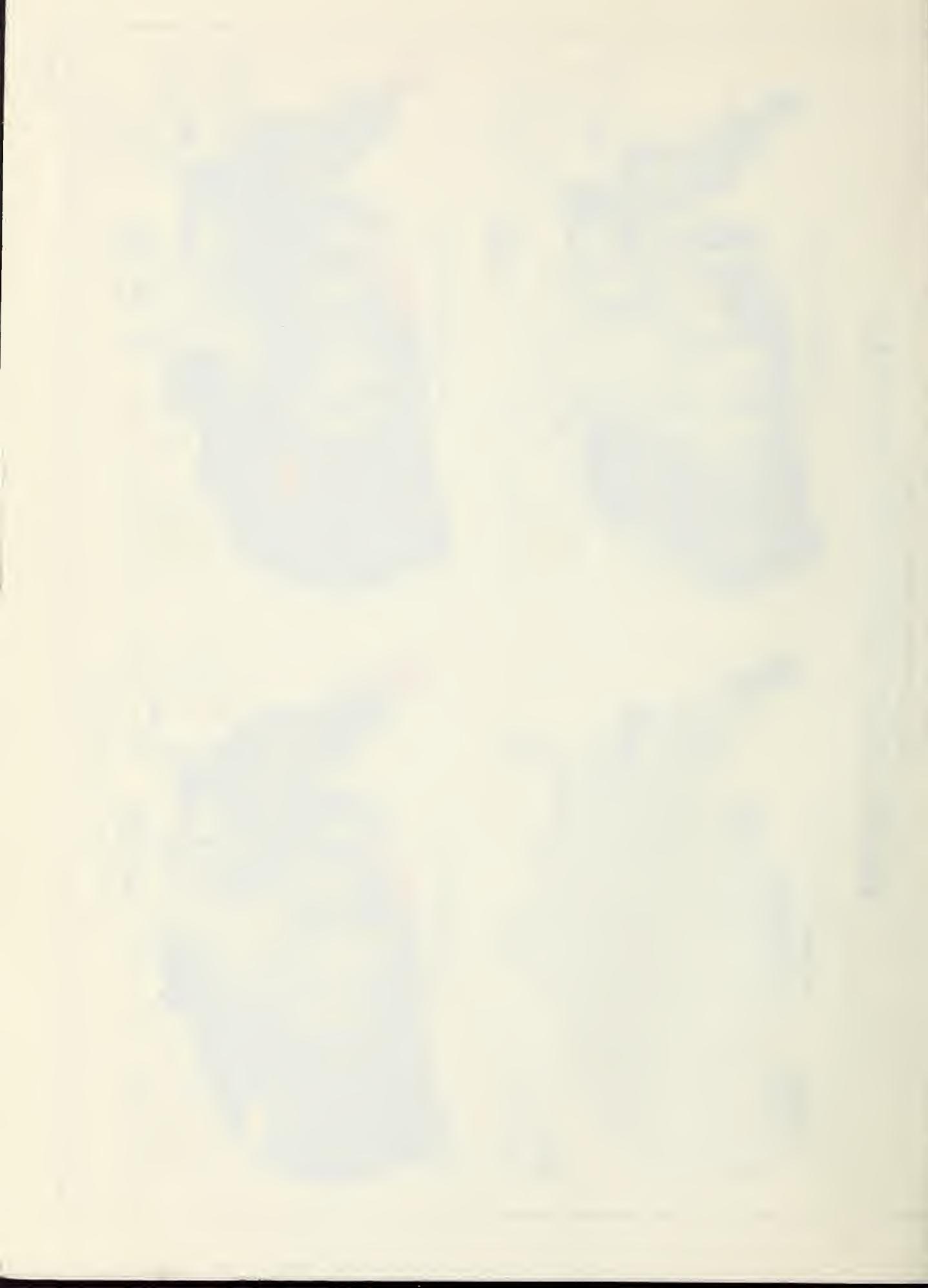
DECEMBER 31, 1961



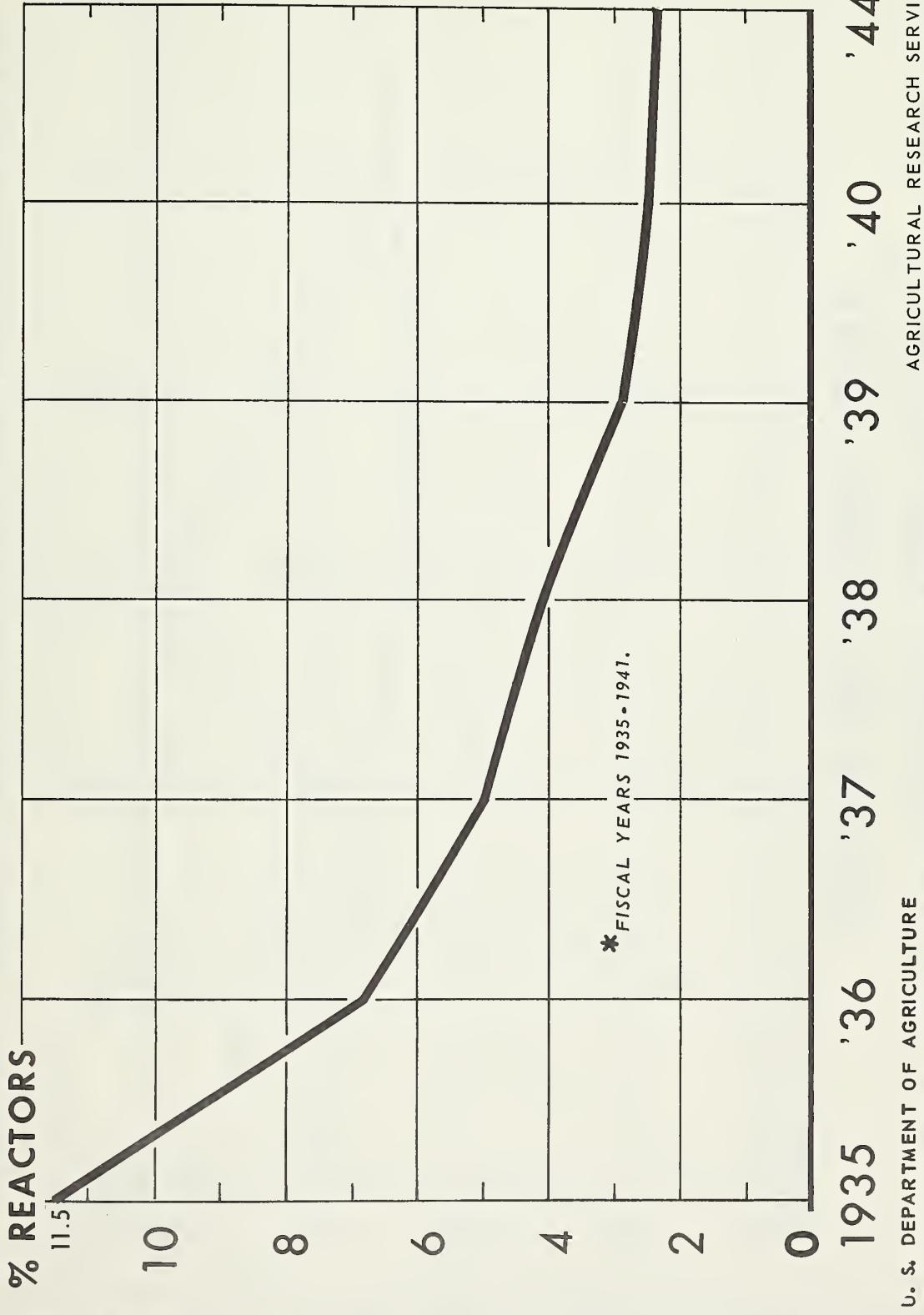
SEPTEMBER 30, 1963

U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE



PERCENT REACTORS-BASED ON BLOOD TESTS*



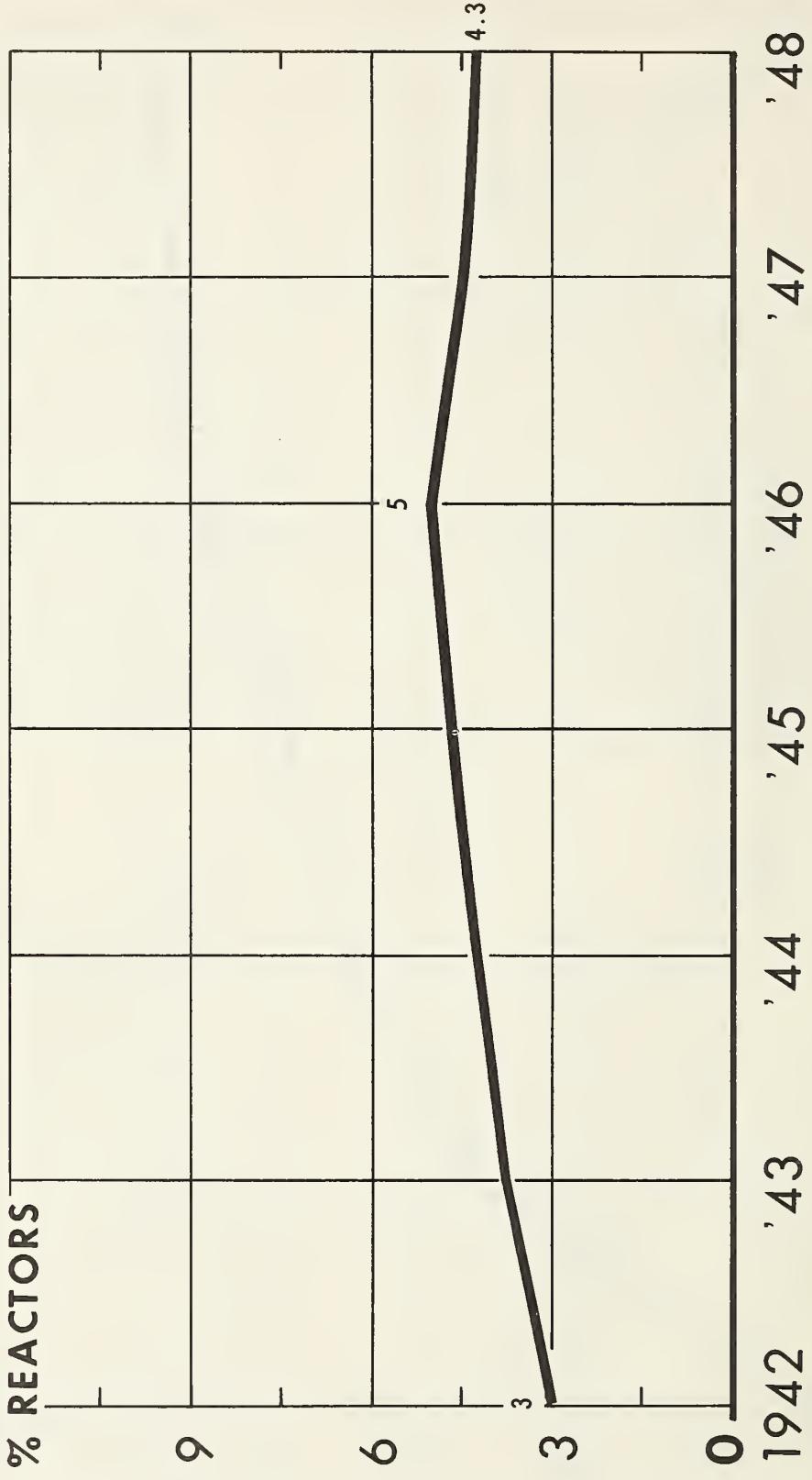
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FIGURE 9

Brucellosis Eradication

**PERCENT REACTORS
BASED ON BLOOD TESTS***



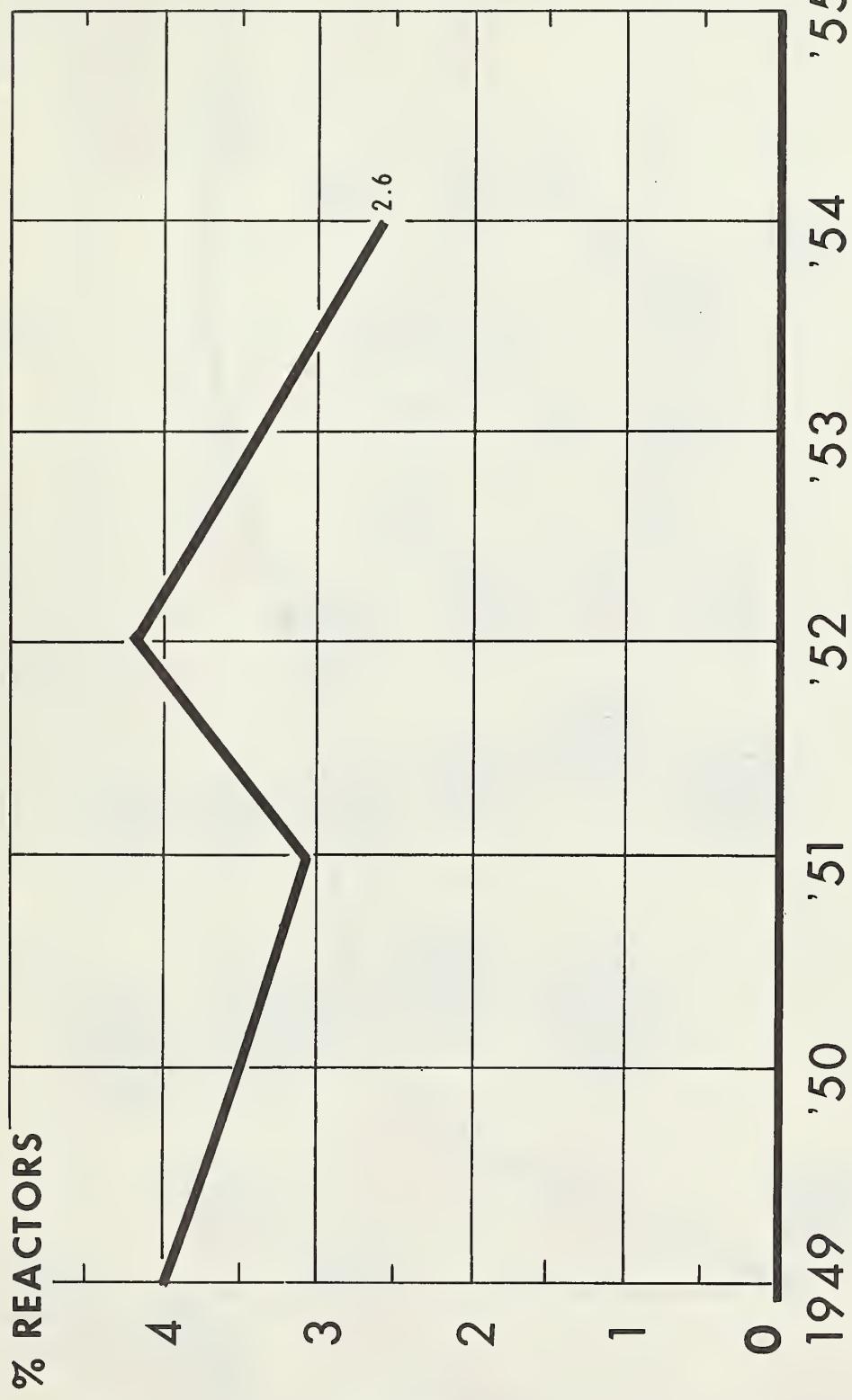
*FISCAL YEARS 1942-1948.

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AGRICULTURAL RESEARCH SERVICE

Bruceellosis Eradication

PERCENT REACTORS-BASED ON BLOOD TESTS*



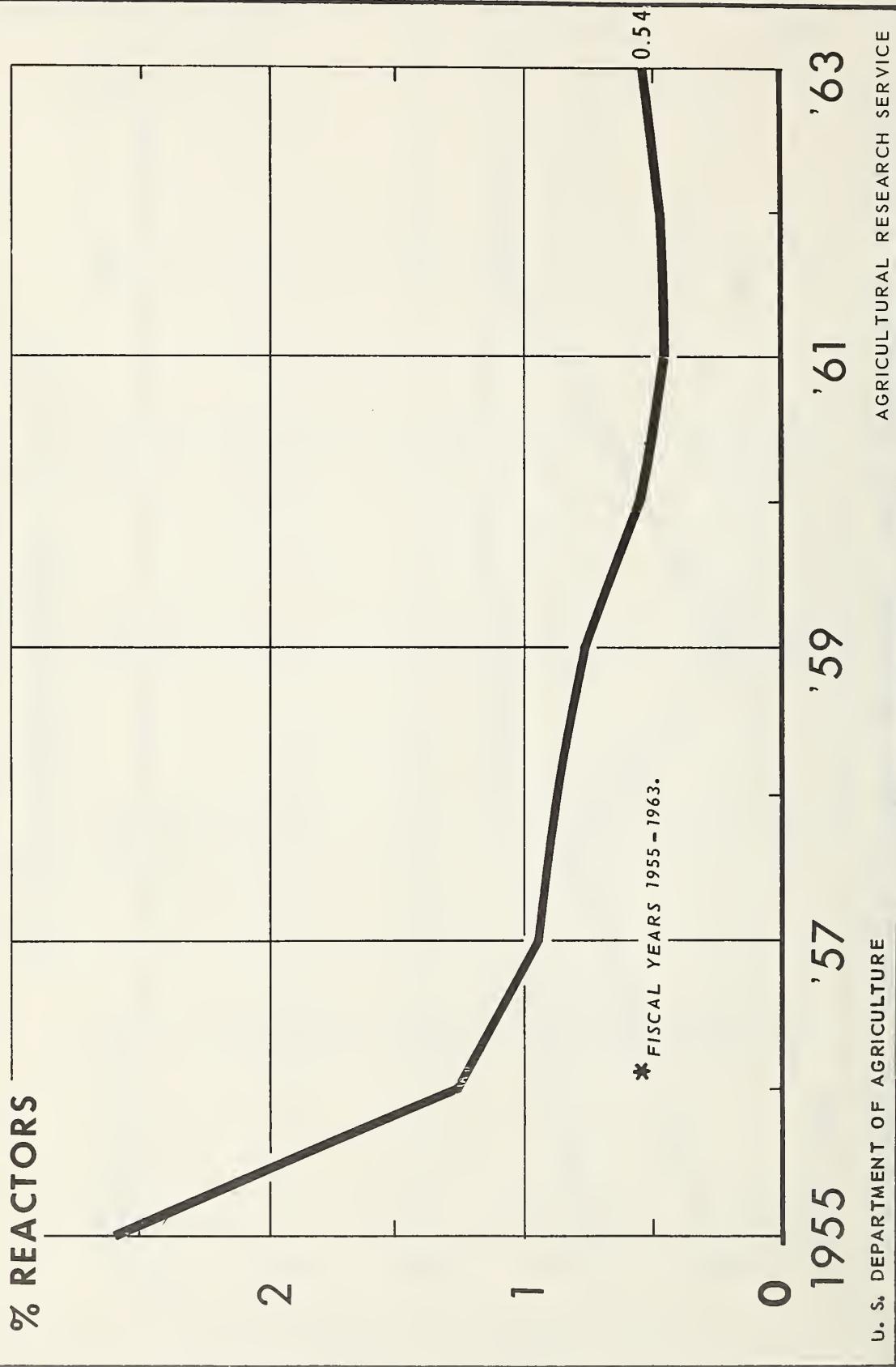
* FISCAL YEARS 1949 - 1954.

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FIGURE 11

Brucellosis Eradication PERCENT REACTORS-BASED ON BLOOD TESTS*



U. S. DEPARTMENT OF AGRICULTURE

AGRICULTURAL RESEARCH SERVICE

FIGURE 12

BRUCELLOSIS ERADICATION PROGRAM

Goal-June 30, 1965

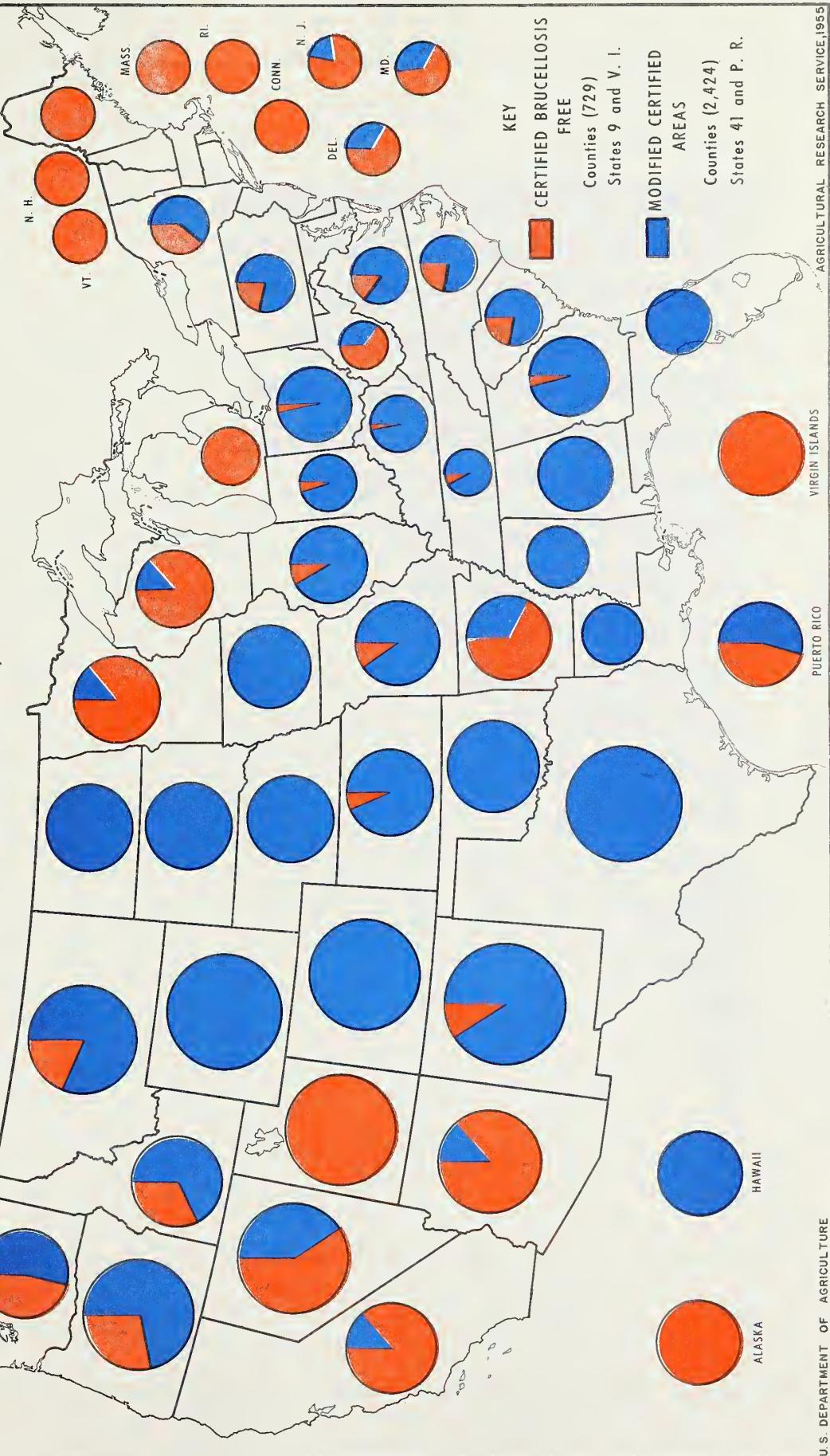


FIGURE 13



Brucellosis Eradication

PERCENT OF ELIGIBLE CALVES VACCINATED

80

60

40

20

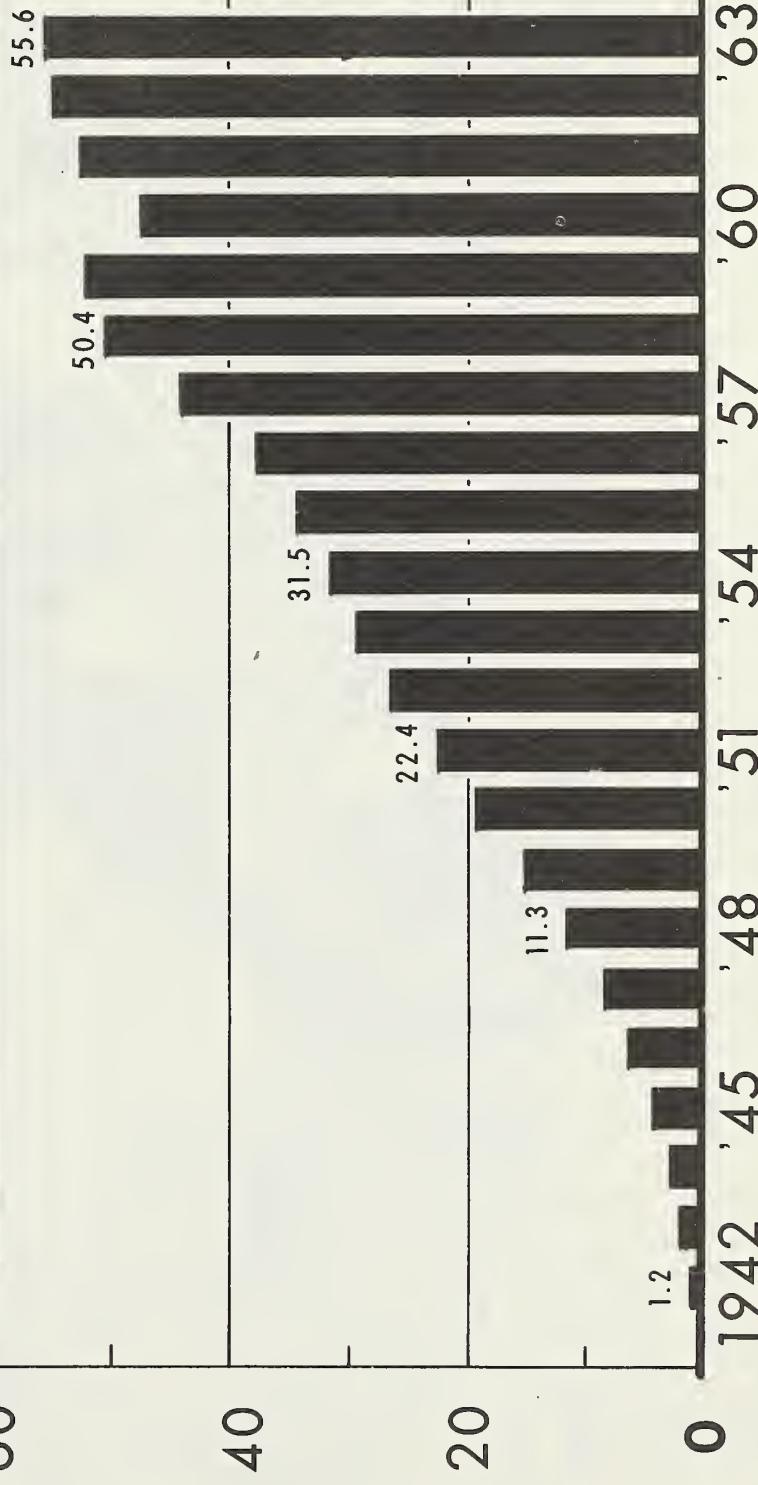
0

60

40

20

0



U. S. DEPARTMENT OF AGRICULTURE

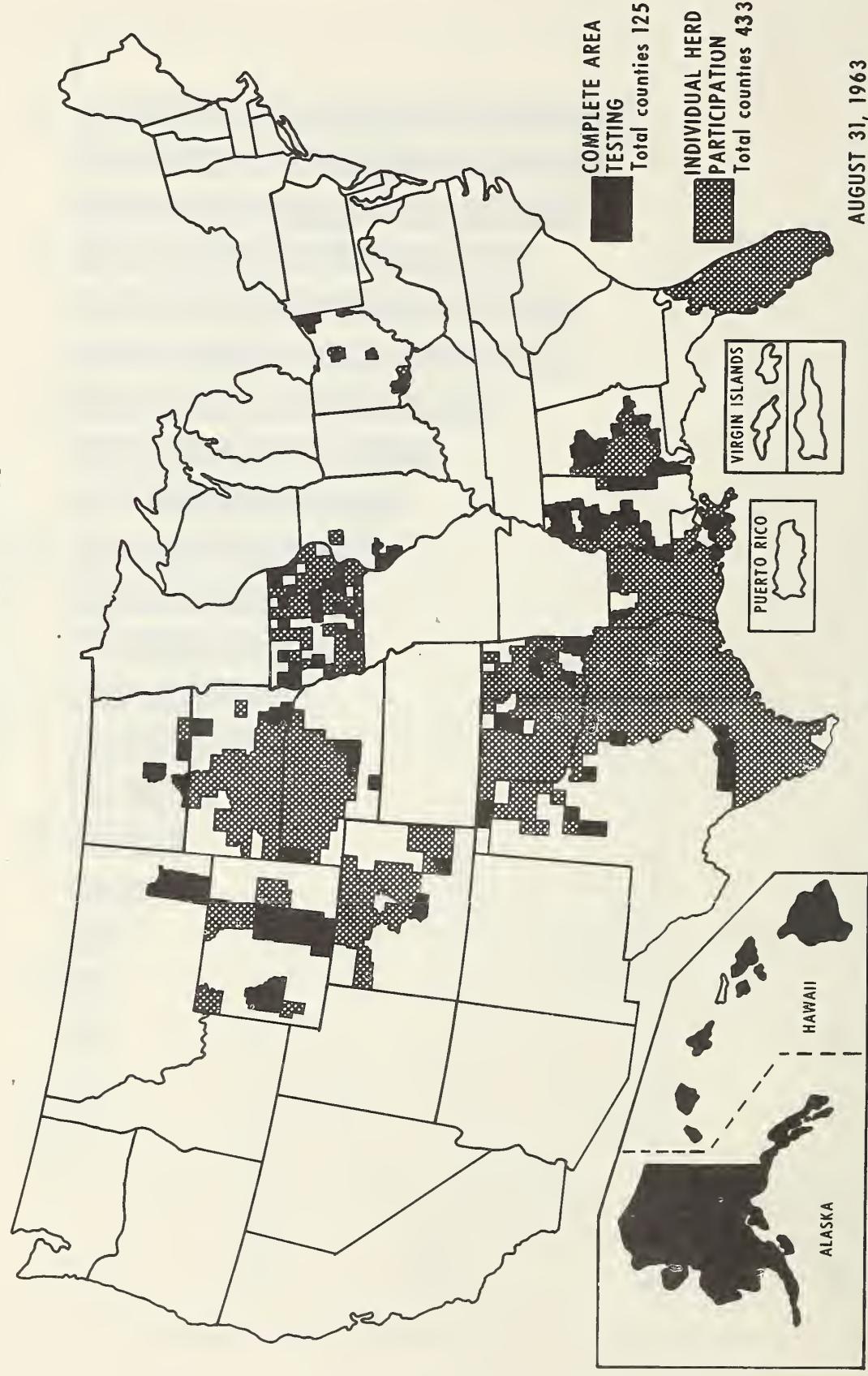
FISCAL YEAR

AGRICULTURAL RESEARCH SERVICE

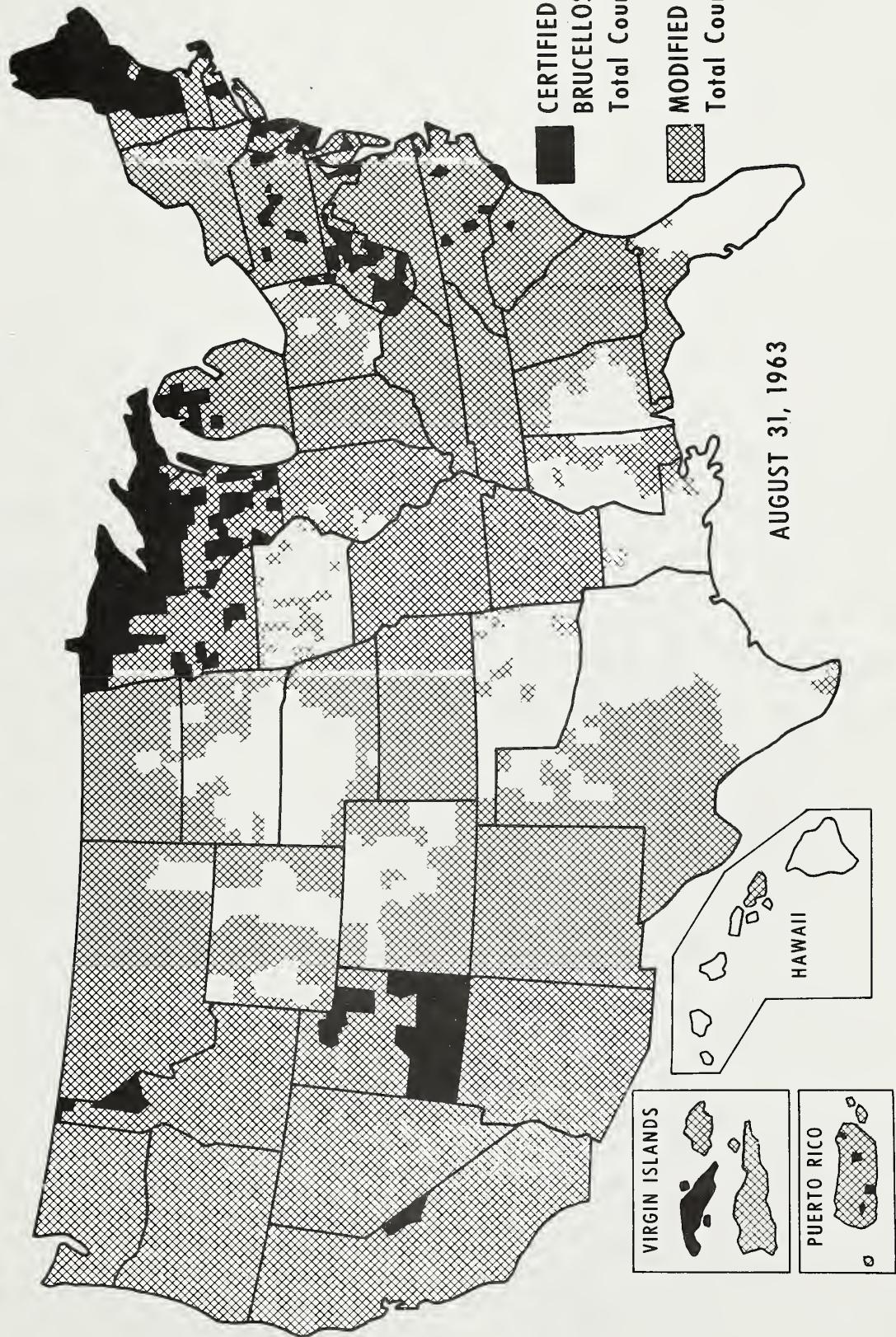
FIGURE 14

BRUCELLOSIS ERADICATION

NON-CERTIFIED AREAS



CERTIFIED AREAS



1. *Glaucomysoreocanadensis*

2. *Glaucomysoreocanadensis*

3. *Glaucomysoreocanadensis*

4. *Glaucomysoreocanadensis*



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